THE

ELECTRICAL REVIEW.

VOL. XLIII. SEPTEMBER 23, 1898. No. 1,087.

CONTENTS:

	PAGE
Some Motors and a Moral	437
Charging Secondary Batteries	438
Permeability under Cross-Magnetising Forces	439
A New Form of Alternating Current Instrument (*illustrated*) ...	439
The Doe Primary Battery	440
Side Lights on Cable Routes	441
Reviews:—The Indicator Hand-book	443
Mechanical Engineers' Office Companion	443
Aluminium as an Electrode in Cells for Direct and Alternate Currents (*illustrated*)	443
The Eight Hours' Day	445
Thermal Efficiency of Steam Engines.—I.	446
Hawthorn (Victoria) Electric Lighting Scheme	446
The British Association Discussion on Motors	448
Correspondence:—*Re* Pacific Cable	448
Aluminium Importers	449
Business Notices, &c.	449
The New Alternators for the Metropolitan Electric Supply Company (*illustrated*)	453
A Great Advance in Fire Alarm Telegraph Protection	454
Notes	461
City Notes	464
Traffic Receipts	464
Share List of Electrical Companies	465
Market Quotations	466
The British Association:—	
On the Pacific Cable	467
The Electrolytic Corrosion of Water and Gas Pipes by the Return Currents of Electric Tramways (*illustrated*) ...	468
New Patents	472
Abstracts of Published Specifications	472

THE

UNIVERSAL ELECTRICAL DIRECTORY

1898

Edition

Price 6s.

H. ALABASTER, GATEHOUSE & CO.,

4, LUDGATE HILL, LONDON E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON.

Telegraphic Address: "AGENCY, LONDON." Code A B C.

Telephone No. 993 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 23, Rue de la Banque. *Berlin:* ASHER & Co., Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to MR. H. ALABASTER, 4 Ludgate Hill E.C.

SOME MOTORS AND A MORAL.

THE three papers on the application of electric motors which were presented in the Mechanical Section of the British Association, and reproduced in our last issue, gave rise to a debate which was mainly remarkable for the bitterness imported into it. The papers were scarcely written in a style to provoke controversy, Mr. Siemens chiefly confined himself to setting forth the results that had been achieved at Charlton, with continuous currents, Mr. Gibbings merely recorded the methods adopted by the Bradford Corporation in extending the distribution of electric power among small consumers, and Mr. Geipel's paper consisted of a general survey of the economies of electric power and a description of a new three-phase plant. The occasion was, however, deemed by Prof. Thompson sufficient to warrant him inveighing in unmeasured terms against continuous current motors, and indulging in a piece of special pleading on behalf of the three-phase system. Neither the former deserved his condemnation, nor did the latter need his advocacy. Few electrical engineers would be inclined to question the merits of the three-phase alternating system, and there is no reason to doubt that its use will be considerably extended. As we pointed out some time ago, it only needed some settlement of the patent question to induce English engineers to look with favour upon three-phase plant, but to argue that because three-phase motors are doing excellent work in some places, therefore continuous current motors are hopelessly out of date, suggests a lack of knowledge of English electrical engineering, or a desire to think that no good thing can come out of this country.

Considering a little more closely the points raised by the readers of the papers, the most striking and suggestive feature presented by Mr. Siemens is that which demonstrates the decrease in the cost of electricity with the increase of the size of the dynamo. Such a statement has been long ago elevated to the status of an electrical engineering maxim but to some minds it was doubtful to what extent it really existed. It was obvious that the cost of operating a moderately-sized plant would compare unfavourably with the cost achieved in public supply works. One was, however, scarcely prepared to find that most public electricity works could supply electricity for motive power purposes at a lower rate than it could be produced in a place possessing the skilled labour and the knowledge of economics of Messrs. Siemens Bros.' works. Yet no other conclusion is possible in face of the figures presented by Mr. Siemens. It must be remembered that the electric driving machinery at the works of Messrs. Siemens Bros. is of considerable magnitude, in fact, the output of the generating station in 1897 was 1,178,286 units, yet in spite of the large demand for electricity the total cost per unit is 2d. It is true that the load factor is not of the best, but it compares favourably with that of a public central station.

The moral to be drawn is that it is possible for a public supply undertaking to furnish electricity at lower costs than it is possible to make it even in large engineering works. Consider for a moment the total output of some public works. Bradford, during the year 1897, sold 993,558 units, yet with its distribution losses, its repairs and maintenance, the total costs were but 1·79d. It is not necessary even to cite

so large an output as that of Bradford. Whitehaven, with 178,378 units, Nottingham, with 480,381 units, and Nelson, with 68,768, can show better figures than those obtained at Messrs. Siemens. It is true that to make the figures really comparable one ought to include something for depreciation, but the comparison would not be materially affected. It was not Mr. Siemens's intention, however, to show that it was better to make your own electricity than to take it from a public supply; indeed, he was quite of the contrary opinion, and quoted an instance of the public supply of Waldenburg, in Silesia, which could have supplied the whole of the electricity used at the Charlton works for £2,000 less than it actually cost Messrs. Siemens to produce. The very same economy could be effected in this country, and Bradford, Manchester, or any large town would be capable of meeting a large demand for motive power at 1·8d. per unit, which is the price charged by the Waldenburg Company. It is but reasonable to anticipate that most supply works will eventually lay down special mains for motive power purposes, and the time is now ripe to cultivate the larger class of consumer, but to do so successfully will call for an outlay of capital far beyond the dreams of the present electricity committees. Mr. Gibbings's paper shows distinctly the trend of the small motor in industrial centres, and there is no doubt that the scheme of hiring which he specially emphasised in his paper, has done much to encourage the user of small power to adopt electric motors. The hiring feature may not appeal to everybody, but it seems to have proved a useful means of extending motors, judging from the fact that 42 hired motors were connected to the mains in the first six months of 1898, against six owned by the consumer. We are afraid that Mr. Gibbings takes a somewhat exalted view of the motor, when he attributes to it the power to improve the social and hygienic conditions of life. Powerful a factor though the motor may be in the industries of the world, it can scarcely work so great a revolution as to revive the small and independent industries of former ages. The aggregation of workpeople in factories is on some grounds to be deplored, but cheap and quick production render it necessary; moreover, we doubt whether the sanitary surroundings of the artisan would be much improved if he did his work at home. No one can quarrel with the generalities that abound in Mr. Geipel's paper. We have heard before the woeful tales of losses in shafting and steam pipes, and the extraordinary economy effected by the substitution of electric motors; it is good to repeat them, however, for one wants to enlarge the audience before which we can proclaim the good of the electric motor. But Mr. Geipel holds a brief for three-phase plant, and equally with Prof. Silvanus Thompson he is somewhat unfair to the direct current plant. The very economies that Mr. Geipel quotes so largely have been mostly attained with direct current motors. But to bring forward instances that tell against any of the systems is not difficult. Mr. T. Parker in the course of the discussion declared he had taken out three-phase machinery and substituted direct current plant; on the other hand, we have ourselves knowledge of a case where three-phase motors have replaced a direct current system. Then, again, it can be urged that the most prominent use of electric motors at the present time is for the propulsion of tramcars, and on these continuous current is almost exclusively used. There is much to be said for both continuous and three-phase, and it is extremely probable that single-phase alternating may also shortly find numerous adherents.

To preach three-phase in the manner of Prof. Silvanus Thompson is to under-rate the knowledge and intelligence of English engineers. Great progress will be made in electric power work, but many years will elapse before it is entirely on one system.

CHARGING SECONDARY BATTERIES.

The paper read before the B.A. meeting by Messrs. Cahen and Donaldson on this subject is one of considerable importance to electrical engineers in general, and to those interested in battery traction more particularly.

It has for some time been known that batteries could be quickly charged at constant P.D., but what other advantage besides saving in time this method possessed, was not known with any degree of accuracy. Only by a series of careful tests, such as these now described, could the method be examined and results obtained upon which every reliance can be placed. The saving in time in charging, amounting to one-half, is of importance in motor or tramcar work; in such cases the 10 per cent. loss in efficiency which attends this method of charging at constant P.D. is not serious, when we consider the greater capacity also obtained.

This increase of capacity is most difficult to understand, and may be due to the high P.D. acting on the active materials in their uncharged state at the commencement of charge. The P.D., beginning with constant current, is but 2 volts, and reaches 2·5 only at the end of the charge, when the most accessible materials have been already converted, whereas, with a charge starting at 2·5 volts, the action will penetrate more deeply into the substances, they being then in a condition to more readily combine with the liberated elements.

Whatever the true explanation, it is a very valuable advantage in traction work to be able to increase the capacity of a battery by merely adopting a method of charging, gaining thereby 30 per cent. more capacity. This gain has long been known, but never before measured and given to the world.

So far as prior knowledge of its utility is concerned, we may call attention to a communication recently brought before the Société des Ingénieurs Civils de France, by M. F. Drouin, entitled "Tramway Electric Traction by Rapidly Charged Accumulators." We cannot here devote the space necessary to a detailed description of M. Drouin's paper, but the main features of the scheme were the employment of plates (Tudor) of large surface, charging at constant voltage, and utilising part only of the maximum capacity of the battery.

The higher P.D. maintained during discharge after a constant P.D. charge, is also due to the more thorough action of the high P.D. acting from the commencement of charge; this is also an advantage of appreciable value.

It would be interesting to carry the tests still further by charging at still higher P.D. than 2·508. The authors do not state why this particular figure was chosen; what would be the results other than increased heating of the electrolyte, if the charging P.D. were increased to 2·6 or 2·8?

Electrical engineers must feel considerably indebted to the authors for their work, and the able manner in which the results are put before them, for but few engineers have the time or means to find out all these things for themselves with any degree of accuracy.

The only point left unsettled is the effect on the durability of the plates. We have heard it said by an engineer who has used the method without making any measurements to find its actual value, but merely to save time in charging, that the pasted plates are improved under the treatment, and that a longer life may be expected.

The excessive heating at commencement of charging is a loss which can, to some extent, be reduced; it depends, to a great extent, on the superficial area of the plates, and points to the use of thin plates of large area, rather than thick plates of small area; this, however, is governed by the question of mechanical strength. Different types of plates will no doubt give somewhat different results, as the internal resistance of the cells differ with different constructions of plates.

It seems that the secondary battery is still a subject for profitable investigation.

PERMEABILITY UNDER CROSS-MAGNETISING FORCES.

By W. H. EVERETT.

The two latest contributions to this subject, so far as I have been able to find, were published in a contemporary in 1890; and it is rather surprising that both of them are disfigured by fundamental errors, which seem to have hitherto escaped notice. It may be sufficent to point out one of these errors as a sample.

The authors of one of the articles give some experimental results obtained by means of a well-devised arrangement for producing two magnetisations at right angles. Their second figure includes two **B**—**H** curves, one showing the behaviour of a certain piece of iron under the action of a single magnetising force, the other giving the results when a force at right angles is simultaneously applied. Comparing the second of these curves with the first, the writers observe that "the permeability shows a large decrease, due, of course, to the fact that the plane of induction alters with each alteration of the transverse magnetisation; and the secondary only measures the component of the induction perpendicular to itself." Now this explanation is erroneous; for the component of a vector in any direction is not affected by the addition of a perpendicular vector, unless the vectors in these two directions are physically dependent on each other. For example, the component magnetising force in any direction is not affected by the application of a force in a perpendicular direction. Yet the writers proceed to argue that magnetisations in perpendicular directions are independent, although their own instructive experiments prove the opposite.

Suppose that a total magnetic force, **H**, is acting at a point, and that an induction, **B**, is thereby produced. In general, **B** and **H** will not coincide in direction unless the matter is isotropic. Let μ denote simply the ratio of the magnitudes of **B** and **H**. Resolve **B** and **H** along any direction x, their components being $\mathbf{B}_x$ and $\mathbf{H}_x$.

Then

$$\frac{\mathbf{B}_x}{\mathbf{H}_x} = \frac{\cos \widehat{\mathbf{B}\,x}}{\cos \widehat{\mathbf{H}\,x}}\,\mu.$$

And if the matter is isotropic,

$$\frac{\mathbf{B}_x}{\mathbf{H}_x} = \mu = \frac{\mathbf{B}}{\mathbf{H}}.$$

The ratio $\mathbf{B}_x/\mathbf{H}_x$ may be called the effective permeability for the direction x. It follows, then, from the above equation that the effective permeability is, in isotropic matter, the same for all directions, and is equal to the true permeability or the ratio of the total induction to the total magnetising force.

Accordingly, if a transverse force, $\mathbf{H}_y$, is applied to any portion of a magnetic circuit where a longitudinal force, $\mathbf{H}_x$, is acting, the effective longitudinal permeability will in general be altered in this portion, and hence also the total flux of longitudinal induction through every section of the circuit. For $\mathbf{B}_x = \mu\,\mathbf{H}_x$, whereas in the absence of a transverse force we should have $\mathbf{B}_x = \mu_x\,\mathbf{H}_x$, μ denoting the permeability corresponding to the resultant force $\sqrt{\mathbf{H}_x^2 + \mathbf{H}_y^2}$, and μ_x the permeability corresponding to the force $\mathbf{H}_x$. Therefore the application of $\mathbf{H}_y$ diminishes $\mathbf{B}_x$ if $\mu < \mu_x$, as is usually the case; but with small forces the effective permeability may be increased, and for certain pairs of values of $\mathbf{H}_x$ and $\mathbf{H}_y$ it will remain unchanged.

A notable example is the case of the transverse component of the magnetising force due to the current round the armature of a dynamo.* This must slightly lessen the effective permeability of the iron in the armature for the lines of induction due to the field magnet, and must also have a similar effect on the pole-pieces, which form part of the return circuit for the lines due to the current in the armature. Besides this transverse component, there is, of course, the counter magnetising component which accompanies the forward lead of the brushes.

Since the coil of every electro-magnet (except a uniformly and closely wound ring) gives a transverse component of magnetic force at nearly all parts of its field, it follows that the longitudinal permeability must be thereby more or less affected. In the case of very long cylindrical coils this transverse force is comparatively unimportant, being very small except near the ends, but in short coils it is by no means negligible.

An error of very small (probably negligible) magnitude will be caused by this effect in the determination of permeability by the bar and yoke method.

There is a different method of treating the subject, which we will merely now indicate briefly:—

Let there be a magnetising force, $\mathbf{H}_1$, at any point in a piece of isotropic iron, and suppose an induction, $\mathbf{B}_1$, is thereby produced. If, now, a second force, $\mathbf{H}_2$, is applied there will be a definite resultant force **H**, and this will produce a definite resultant induction **B**. This **B** is *the* induction, and, since the iron is isotropic, it will have the same direction as **H**. The direction and magnitude of **H** are independent of isotropy. Suppose, now, that $\mathbf{H}_2$ be regarded as producing an induction $\mathbf{B}_2$, such that $\mathbf{B}_1$ (existing before the application of $\mathbf{H}_2$) and $\mathbf{B}_2$ give **B** as their resultant. Then we have to consider the state of the iron with respect to the additional force, and it will be found to be curiously colotropic.

The full investigation is too long to give here. Various cases have to be considered, depending on the values of $\mathbf{H}_1$ and $\mathbf{H}_2$. In the most notable case we find that if $\mathbf{H}_2$ is a generator of either of two cones, having the direction of $\mathbf{H}_1$ as their common axis, it will experience a permeability equal to μ_1; for any direction lying between the cones the permeability will be greater than μ_1, and for other directions less.

* See Prof. S. P. Thompson's "Dynamo-Electric Machinery," fifth edition, p. 86; see also the works of Dr. Werner von Siemens, English edition, p. 353.

A NEW FORM OF ALTERNATING CURRENT INSTRUMENT.

By ARTHUR C. HEAP.

There are two sources of error in amperemeters and voltmeters for use in alternate current supply stations which have not received the attention they warrant, namely, errors due to change in the periodicity and wave form of the supply current.

If the condition of supply is constant pressure, it is especially important that the voltmeters should be free from errors due to the above causes. The usual practice at the present time is to employ electrostatic or hot wire instruments. The former are open to the objection that the forces dealt with are so small that they are necessarily of very delicate construction, and further, cannot be made as recording instruments, and the latter to the fact that they take some time to come to their correct reading, and many of them vary considerably when placed in a draughty engine room.

To overcome these sources of error and to produce an instrument which shall at the same time have plenty of power in its working parts, negligible temperature error, and consume few watts, the writer has designed the following method of construction, which will be best described by reference to fig. 1.

M M is an electro-magnet built up of laminated plates of transformer iron, shaped as shown; the section for an ordinary instrument being about 8 square centimetres, the length of the limbs 8 centimetres, and yoke 6 centimetres, and is so made that the yoke can be easily withdrawn to allow the coils, P P, and S S, to be slipped on. The weight of the iron circuit is about 1½ lbs. An iron core, M′, is fixed between the pole pieces, leaving an air gap of about 2 mm. on each side.

Between it and the pole pieces a coil of wire, C, carrying a pointer, is pivoted so as to be free to turn in this air gap against the action of springs or gravity. Round the iron circuit a number of turns of suitable wire, P P, are wound; these are connected to the source of supply, and form the exciting circuit of the electro-magnet: over these an entirely distinct set of turns, S S, are wound, and the ends of these

are connected to the terminals of the pivoted coil, C, through an adjustable resistance, R.

It is, therefore, seen that the secondary current induced in the S S turns by the alternating current in the primary, P P, passes through the pivoted coil, C, which is free to move

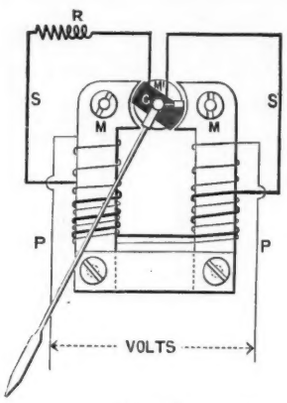


Fig. 1.

in the magnetic field created in the air gap by the primary turns; the coil turns through an angle which varies with the volts applied at the terminals of the primary, and the amount of such movement is indicated by the pointer on a scale in the usual manner.

The number of turns on the primary coils, P P, and the resistance, R, are regulated according to the voltage of the circuit on which the instrument is to work.

Table I.—Voltmeter.

Divs. def. on Inst. Scale.	Volts.		
	From London Electric mains 83 ~	From alternator 83 ~	From alternator 43 ~
5·9	0	0	0
8·4	10	10·1	10·
11·6	20	20·	20·
15·0	30	30·	30·
20·4	40·1	39 95	40·
25·2	50·	50·1	50·
30 6	60·	60·	60·
36·0	70·1	70·	70·
42·0	80·0	80 0	80·0
47·5	90·	90·	90·
53·2	100·1	99 9	100·
58·5	110·0	110 0	110·15
63·5	120·0	120 0	120·

In order that the indications may be free from periodicity and wave form errors, it is necessary that the magnetic leakage should be small and remain constant; the air gap is

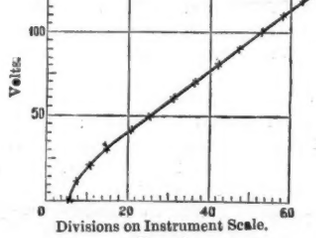


Fig. 2.

therefore made small, and the secondary turns are wound on the lower half of the magnet limbs, as far from the pole pieces as possible.

A voltmeter made on this plan is free from errors due to periodicity and wave form over a very wide range, as the figures in Table I. show.

The readings for column 3 were taken on an instrument working from an alternator with slotted iron core, having an almost flat wave form at a periodicity of 83 ~. Those in column 4 are for the same instrument working off the same alternator at a periodicity of 43 ~, and those in column 2 are for the same instrument working on the mains of the London Electric Supply at an average periodicity of 83.

The three curves plotted from the above figures lie exactly over one another (fig. 2), and show that the alteration in wave form between the iron core armature alternator and that of the London Electric mains, and a change in periodicity of 50 cycles per second, make no difference in the readings of the instrument.

An amperemeter is constructed on the same plan, using the same iron circuit and moving coil, the primary turns being few in number, and of large section suitable for the current to be measured, or the turns, P P, may be similar to those used for the voltmeter, and are then supplied with current from a suitable series transformer, the primary of which carries the total current to be measured, the secondary being connected to P P. The resistance, R, is replaced by inductance.

One advantage of this method of construction is that instruments can be supplied with two or three or more ranges; in the case of a voltmeter, by bringing separate windings out to separate terminals on the instrument, and in

the case of an ammeter by supplying two or more series transformers, having different current capacities arranged to work to the one indicating instrument. Where recording ammeters have to be used on high tension circuits, these transformers can easily be well insulated, and with a suitable earth connection, make it that the instrument can be handled for changing charts, &c., with perfect safety.

A considerable amount of experimental work has been carried out at Messrs. Elliott Bros., 101, St. Martin's Lane, who are the sole makers of the different types of recording and indicating instruments, and to whom the writer is indebted for many valuable suggestions.

THE DOE PRIMARY BATTERY.

Under the title of "The Doe Portable Electric Light and Power Syndicate," a company is being formed to exploit an improved form of primary battery, the invention of Mr. W. S. Doe. As far as can be judged, there appear to be certain points of mechanical construction in the cell which are decidedly good. Everyone who has had to deal with primary batteries knows what exceedingly messy things they are at the best. What with leaky cells, badly fixed zincs and carbons, corroded terminals, and all the rest of it,

they, after a very short time, inspire unmitigated disgust, especially as the pretensions of the inventors are almost always far from being borne out. Some of our readers will doubtless recollect the *very* early days of the fountain pen, and the lively appliances they were. The pleasure which was felt on withdrawing one of these pens from the pocket and discovering that the ink had nearly all leaked out, was immense; now, however, thanks to proper mechanical skill having been devoted to the subject, perfectly tight joints and freedom from all the disagreeables which were at first inherent in the appliances, have disappeared, and the result of good workmanship and design is that perfectly tight screw-joints are obtained without the use of rubber washers, &c. So it will, we believe, be the case with portable batteries. The use of "built up" cells made in numberless parts, ill fitting, badly designed, packed with all sorts of asphalte or bituminous cements which are supposed to prevent the metallic connections from becoming corroded, but which do not do so, all these will eventually be got rid of and then there will be some chance for the cells coming into confidence. If Mr. Doe has been working in this direction, there is some hope for his inventions. The possibility of using zinc electrodes which can simply be dropped into the cell when required for use is a vast stride in the right direction, and if the statement that the electrolyte is such that polarisation is reduced to a point which has hitherto not been approached, is correct, another distinct advance has been made; but of this we, at present, are sceptical. The prospectus, like all other prospectuses of the kind, is full of ridiculous statements; who ever heard of a battery electrolyte that was "explosive and inflammable." Yet it is thought necessary to inform the public that "the electrolyte is a clear, colourless fluid, absolutely harmless to handle, non-explosive and non-inflammable."

We are also informed that "it had been found impossible to get a primary battery that would maintain an even current, all other primary batteries quickly polarising," a statement which is absolutely untrue. It may, however, be doubted whether those who drew up the prospectus know what polarisation means, if we are to judge from the following paragraph:—"As evidence that this battery does not polarise, it should be stated that, of the numerous batteries which have been in constant use in England for over six months, in no single instance has any sign of polarisation been detected," which is simply downright nonsense. It is also claimed that for many purposes of *motive power*, where oil and gas are useless, the battery will prove useful; this remains to be seen. In the meantime we have favourable reports from the late Dr. Hopkinson, and Messrs. Houston and Kennelly, on the merits of the battery, about which we shall be interested to learn more.

Let it not be forgotten, however, that the battery consumes zinc, and therefore the electrical energy produced is 20 to 30 times as expensive as that from a steam engine and dynamo, although we must confess that the chief uses to which the battery is intended to be applied are in the legitimate field of a primary battery. The purchase price, £30,000, from a capital of £40,000, is altogether out of all proportion to the value of such an invention.

Since the above was set we have gone further into the matter and added a few brief comments in our "Notes" columns.

SIDE LIGHTS ON CABLE ROUTES.

I.

As a study of what we may fairly enough call an unsuccessful intrigue, we commend to the attention of our readers a report printed in June last by order of the Speaker of the Cape of Good Hope Parliament, headed "Copies of Communications that have passed between the Government of the Cape Colony, the Imperial Government, and the Eastern Telegraph Company, on the subject of a Deep-Sea Cable *viâ* the Cape, with extension to Australia." The frank audacity of some of the proposals advanced by the Eastern Telegraph Company and its backers would come as an amusing relief in the perusal of these letters were it only new, but for those who have any knowledge of the methods by which in the East and in Australasia these companies have gradually acquired their present monopoly, the freshness of the style has altogether disappeared.

To lay the matter clearly before those who may not care to wade through these letters, we may state shortly that they refer to certain proposals made by the Eastern, Eastern Extension, and Eastern and South African Telegraph Companies, to the Imperial Government, and to the Governments of Cape Colony and of the Australian Colonies. Of these cable companies, the Eastern and the Eastern and South African are practically one in all but name, and are both under the able management of Mr. J. Denison Pender, who is also a director of the Eastern Extension Telegraph Company, the interests of which are most closely allied with those of the other two companies, the Marquis of Tweeddale being chairman of this as well as of the Eastern Company. The community of interests above indicated obviously calls for joint action in cases of need. Now, for some years past (since about the time of the Transvaal difficulty), the telegraph lines to the Cape and South Africa generally, have given much trouble, and caused much dissatisfaction, owing to the frequent breakages; these lines run along both the east and west coasts of Africa, the Eastern and South African owning all those on the east, and a portion of those on the west coast. This company, therefore, suffers both in purse and credit, owing to the frequent interruptions, which besides, might possibly make the laying of an opposition cable necessary, thus entailing serious competition, reduced rates, and consequent loss. Such a position clearly requires remedy. The allied Eastern Extension Company also is not free from the serious danger of competition, should a cable over which they have no control be laid between Australia and Canada. This also requires attention. The papers now published by the Cape of Good Hope Parliament expose the manner in which the combined companies hope to find relief from the troubles above indicated, but not at their own expense.

About the beginning of this year frequent reference was made in the press, many paragraphs appeared concerning an "All-British cable to Australia, *viâ* the Cape, and touching at various places *en route*, which, in return for "certain privileges," would be laid by the companies above mentioned. The nature of these privileges is given in a letter dated March 22nd, 1897, addressed by Mr. J. Denison Pender to the Chancellor of the Exchequer. In this letter, after referring to the demand for "additional telegraphic communication between Great Britain and the Australasian colonies, quite independent of the Mediterranean route," Mr. Pender proposes that the combined companies should provide "cables between England, the Cape, and Australia, touching only at Gibraltar, Sierra Leone, Ascension, St. Helena, Durban, Mauritius, Rodriquez, and Cocos." In consideration of the above, the "privileges" asked for are the following:—£25,000 annually for 20 years from the Imperial Government; an extension by the Australasian Governments, for at least 10 years, of the annual £32,400, which they have been paying to the Eastern Extension Company for the last 19 years; also a present of a double-wire landline (about 1,000 miles long) between Cape Town and Durban, from the Governments of Cape Colony and Natal, a landline which, as the Postmaster-General of Cape Town points out, is equivalent to a perpetual subsidy of £12,000 per annum. An underground landline service from London to Cornwall is also to be provided; this will cost the Imperial Government at least £50,000. In addition to the above, it is stipulated that an annual subsidy of £32,000 for 20 years shall be paid if a branch cable be laid from the Seychelles to Ceylon, touching at Diego Garcia on the way. The financial side of the proposal having been set forth, Mr. Pender asks for "an undertaking by the Governments concerned that, for a fixed period, they will not subsidise any opposition line connecting any of the places served at present by the associated companies. On their side, the companies to undertake to increase their cables whenever necessary to meet public requirements. This principle was, to some extent, formally recognised by the Imperial Government, with the approval of the Australasian Colonies, when the Eastern Extension Company's Singapore-Labuan-Hong Kong cable was laid in 1894." The qualifying words, "to some extent," are very much

needed here, as Article 7 in the agreement between Lord Ripon (then Secretary of State for the Colonies) and the Eastern Extension, &c., Company, concerning the Singapore-Labuan-Hong Kong cable runs as follows:—"Nothing in this Agreement shall affect the right of Her Majesty's Government to grant to the Government of the Dominion of Canada, or of any Colony in Australia, permission to lay, or cause to be laid, a submarine telegraph cable connecting Hong Kong with Canada or with Australia, provided such connection with Canada or Australia be completed within five years from the date of this Agreement, after which date the exception in this Article mentioned shall become null and void."

In Article 4, Her Majesty's Government reserve the right to permit the laying of cables by others, if "such new cables should in the opinion of Her Majesty's Government be found necessary in the public interest of Great Britain, Hong Kong, the Straits Settlement, or Labuan, or in the general interests of international telegraphic communication."

These quotations, as well as the fact that no subsidy is mentioned in the Singapore-Labuan-Hong Kong cable agreement, show that it is always well to verify references.

This attempt to confirm the existing monopoly of the allied companies would, of course, if successful, have the effect of relieving both the Eastern and South African, and the Eastern Extension Companies, from the awkward position in which they at present find themselves. The Eastern and South African Company would be provided—at Government cost—with an efficient service to the Cape and Natal, and would also be freed from the danger of a competing cable. The Eastern Extension Company would no longer have to count with a competing cable from Canada to Australia, and would, besides becoming independent of the ricketty landlines across Australia, also ensure the continuance of the colonial subsidy of £32,400 annually, which would otherwise lapse next year. The suggested method of securing a monopoly, although sufficiently efficacious, and reaching the limits of any demand to which England could by any possibility accede, is not so thorough as that adopted by these allied companies in their dealings with other countries. For instance, to secure their interests in China against a competing American cable from San Francisco *viâ* Honolulu and the Spanish islands in the Pacific, the Eastern Extension Company, in return for providing an efficient service to Manila from Hong Kong (by moving their cable direct into the town) exact from Spain a prolongation for 20 years, of an absolutely exclusive right to lay cables from Manila to Hong Kong, besides the landing rights on all the Spanish possessions in the Pacific. These rights, owing to the result of the war, are probably now of no value.

To turn again to the letters relating to the proposals of the allied companies, we find that, under date of November 12th, 1897, to the Chancellor of Exchequer, the Marquis of Tweeddale repeats in a modified form that portion of Mr. Pender's letter which relates to carrying the cable from Gibraltar to Cape Town (the subsidy figuring at £20,000 per annum), also the request for landlines from London to Cornwall. The clause intended to shut out competition also recurs, but as regards the line to Australia, Lord Tweeddale writes:—

"This proposal, if approved, would leave for after arrangement the continuation of the cables from South Africa to West Australia, and, in the meantime, would provide the best alternative means of strengthening cable communication with our African colonies by a cable landing throughout on British territory only, as well as placing the important islands of Ascension and St. Helena in telegraphic communication with Great Britain.

"The triplication of cable communication with South Africa has been decided upon, not on account of any abnormal development of traffic, but because it has always been the policy of these companies to ensure the maintenance of communication between all points in their system, more especially between Great Britain and her important colonies; and although it is improbable that with two lines of cable communication between South Africa and Great Britain the telegraph service between these places would ever be totally interrupted for a long period, yet it is considered that with three lines of communication the fear of total interruption would be entirely removed."

The extension from the Cape to Australia is thus shelved for a time. The admission that for satisfactory telegraph service a third line is requisite, quite justifies the opinion expressed in a letter of March 22nd last from the Postmaster-General of Cape Colony, who says, "I would wish to remark that, in my opinion, no subsidy should be given by the Cape in connection with the *revised* scheme, as the traffic receipts at the present time appear to warrant the laying of an additional cable on commercial grounds alone, without the aid of a subsidy from the Cape, or Natal, or any State or colony in South Africa. At all events, if the Eastern Company does not lay a third cable it will be worth while for some other company to do so, and this would lead to competition in rates which would undoubtedly be beneficial to South Africa." The opinion thus expressed by Mr. French in this letter is justified by the information given in his note attached to a telegram from the Agent-General of the Cape to Sir Gordon Sprigg, under date March 9th, from which we quote:—"I have not as yet been able to obtain reliable information as to the total value of the South African cable traffic during the year 1897, but although it will not probably (owing to the depression in the Transvaal) reach the very high total of £300,000 attained in 1896, I have little doubt that it will exceed considerably the limit of £180,000 fixed by the late Sir John Pender as a paying revenue for the existing cables." Mr. French, in this note, also protests against giving a practical monopoly to the Eastern Company, by which they would be in a position to refuse that reduction of the present rates, which will be expected from the company in the near future.

From the evidence given above, and from the notoriously unsatisfactory condition of the lines to the Cape, it seems clear that the Eastern and South African Company and its friends have a duty incumbent on them, not only to provide a third cable, but also to provide it for their own safety; free of subsidy or conditions. The gains from the cable traffic, as pointed out by Mr. French, are more than sufficient to warrant this, and as the only possible alternative route for such a cable is *viâ* Ascension and St. Helena, it is monstrous to call on Her Majesty's Government for assistance in carrying out a work which their own commercial interests absolutely require.

That these companies are not justified in the claim which they make for State assistance, the following figures will prove up to the hilt. Apart from the revenue derived from traffic, and to which Mr. French makes allusion, the Eastern and South African Company already receives, almost entirely from British sources, annual subsidies amounting to £88,000 per annum. The African Direct and West African Telegraph Companies, in which the allied companies are large shareholders, draw from the British and various other Governments annual subsidies amounting to about £65,000. Thus, altogether, the total at present paid in subsidies to the African cable ring amounts to more than £150,000 yearly; and they have already received in this way, quite apart from their traffic earnings, a sum exceeding £2,000,000.

We do not include here the Eastern Extension Company, which we propose to deal with in a future article, but will only remark that this partner in the scheme we have here exposed has, during its existence, drawn well over £1,000,000 in subsidies, besides having a reserve fund of more than £800,000 in hand.

That the proposals made by these allied companies were even thought worthy of consideration by a Departmental Committee appointed by the Treasury, proves nothing beyond the influence which they possess in official circles We are glad to notice that in the draft instructions to this Committee the following: "The Committee will understand that in no case can an unqualified guarantee against subsidised competition be given."

After that part of the scheme, which entailed a prolongation of the cable from the Cape to Australia, collapsed, the Agent-General, in a telegram to the Premier of Cape Colony, asks: "If All-British cable stops at Cape, and proceeds no further, what contribution or subsidy are you prepared to offer—Committee awaits reply." The reply of Sir Gordon Sprigg, dated May 15th last, is perhaps the best which could have been made to the impudent demands of these "sturdy beggars," and runs as follows:—"In letter, December 29th, company offered to lay cable without South African subsidy. As present traffic warrants third cable on basis of revenue laid down by Sir John Pender, feel sure South African contributories to subsidy would not

entertain question of increase without satisfactory guarantee regarding reduced rates, as monopolists company must make concessions to meet legitimate public requirements."

REVIEWS.

The Indicator Hand-book.—Part I. By C. N. Pickworth. Manchester: Emmott & Co.

Many engineers think they know all about indicating and indicators, but few are fully alive to the very many inaccuracies which occur in indicator practice, either in the springs, the connections to the cylinder, the leading off of the barrel strings, or the correct proportioning of reducing gears, this latter a most fruitful source of errors in diagrams. For all ordinary purposes of the steam user the reducing gear need not be absolutely correct, for the chief use of the indicator is to keep a check on the valve motion, to detect faulty steam distribution, and it is by no means necessary to be always calculating power and coal consumption; but where correct coal or steam consumption is to be found in terms of power, the indicator must be correct. In Mr. Pickworth's little book he has sought to fully describe the indicator and its application, and to examine in detail the errors of the instrument itself, and the errors above pointed out of faulty attachment and driving. Like everything else connected with steam engineering, the indicator has been a victim to high pressures and speeds, and has had to be gradually developed from the old form of McNaught and of Hopkinson, which were direct acting instruments, to its modern form, the essence of which is that the piston shall have a very small movement, which shall be multiplied by light levers to give the requisite pencil movement.

Obviously, where the movement of a spring is thus magnified, its errors of movement are also magnified, and this entails great accuracy in the springs. We hope it is not so to-day, but only a few years ago it was customary to soft-solder the springs into their heads. This destroyed the temper of the springs in the first place. In the second place a spring thus made was not likely to be absolutely accurate. It would not do to unsolder it. Consequently it became necessary to always make a spring a little stiffer than it was wanted to be, and it was then reduced to its proper strength by brushing it with a steel wire brush. As the brush could only fully attack the outside of the helix, the section of the spring wire was made to depart from the truly circular. Such springs could not, therefore, be considered first class. Now, the correct manner of making a spring is to nip it tightly in its heads entirely free from solder, and to reduce it to correctness by screwing the heads a little off or on, so as to alter the length of the helix. When correct the nip was made permanent, and not till then was the spring cut to correct length over its heads on their abutting surfaces. In certain American indicators inspected by the present writer a few years ago, the springs were very distinctly faulty, and compared badly with English springs. But one very good spring improvement was due to the Americans in the ball end of the Crosby double helical spring.

The author seems to have described every kind of indicator. There was a time when the number of different styles of instrument could almost have been counted on one's thumbs. Now, all 10 fingers will not count the ordinary types, which are all described and mostly well illustrated, as also are reducing gears.

We see no reference to the name of Casartelli, of Manchester, who was, so far as we know, the first to place the making of indicator springs on a sound and scientific basis. We are glad to be able to recommend the book to those who desire to get up the subject of indicating.

We trust that in Part II. there will be more attention paid to the gas engine diagram, which is not recognised as it ought to be, to be a multiple diagram, and the result is that the indicated H.P. of a gas engine as usually found from one round of the pencil is far from being correct. The gas engine is absorbing power on all revolutions not explosive, and due allowances should be made for these. Obviously, as a gas engine usually takes an equal charge of gas every intake stroke, it is best to count the explosive strokes when light, and when loaded to get at what the load *per se* is absorbing. In this way the gas engine lends itself very well to the finding of the power absorbed by any one machine as the explosions can be counted which are due to the machine. The author might well devote a chapter to this subject in the promised second volume.

Mechanical Engineers' Office Companion. By R. Edwards. London: Crosby, Lockwood & Co., 1898.

Without finding fault with this book, which is a conveniently small book of rules and tables, it seems to us that there was no special call for it. The chief set of tables is good, and consists of 22 columns of all sizes from $\frac{1}{100}$th to 500, carried out as squares, cubes, roots, metrical equivalents, areas, circumferences, strengths at 20 tons per inch, Whitworth thread sizes, and strengths and weights of iron. There are various other tables and rules for machinery proportions, and the whole is nicely printed and arranged. A feature in the book, which is at once convenient and noteworthy, is that there is an index at each end, just inside the two covers, where an index ought to be, and never is.

ALUMINIUM AS AN ELECTRODE IN CELLS FOR DIRECT AND ALTERNATE CURRENTS.*

By E. Wilson.

(*Concluded from page* 435.)

The experiments in figs. 1, 2, 3, give results obtained with an exploring electrode inserted between the plates in the electrolyte as in the first portion of this paper. The aluminium and carbon plates

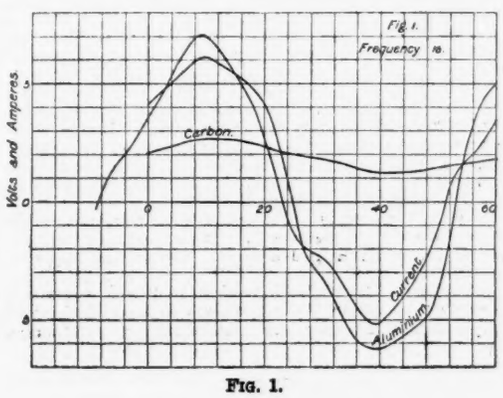


Fig. 1.

in one of the large cells were separated to ½ inch, and the two cells kept in series as in experiments (4) and (5) Table IV. The curves refer to this cell, and provision was made for obtaining the instan-

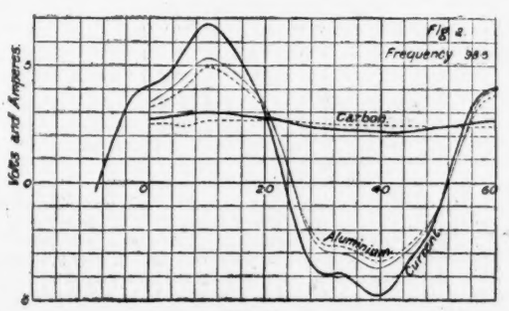


Fig. 2.

taneous values of the current in the cell, and the potentials between the exploring electrode and either the aluminium or the carbon plate.

* Communicated to the Royal Society by the late Dr. J. Hopkinson, F.R.S. Received May 11th; read May 26th, 1898.

In figs. 1 and 2, the Siemens dynamometer in the circuit registered the same current, namely 3·97 amperes, but the frequencies are 16 and 98·5 respectively. We see that $\frac{1}{16}$ second is too short to allow the effect we are looking for to fully develop since the ratio of the maximum coulombs is 1·47. On the other hand, if we examine the two sets of curves we see that at 98 periods per second the potential difference between the exploring electrode and aluminium has a maximum value of 3·63 volts during the half period when the coulombs have the smaller maximum, whereas at 16 periods per second, the same maximum current is produced with a larger maximum potential, namely, 6·27 volts. That the aluminium plate was an anode during the half period when the maximum coulombs were a minimum, was proved by noting the direction of the electrometer

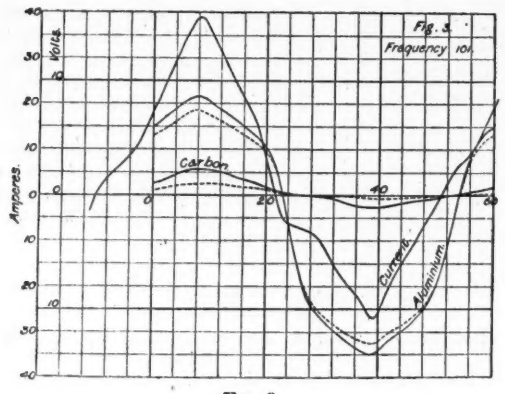


FIG. 3.

deflection, when the positive pole of a Clark's cell was connected to the insulated quadrant, and examining the observed direction of the deflection during the experiment. Experiments made upon the resistance of the electrolyte with two exploring electrodes, employing alternate currents, show that at the temperature at which these experiments were made, namely, 13½° for the 16 frequency, and 11½° C. for the 98·5 frequency, the resistance of a layer of the electrolyte of area equal to the area of the plate submerged, and length equal to the distance between the electrode and the plate has a resistance of about 0·063 ohm. The curves of potential in fig. 2 have been corrected for this, and the dotted lines show the results. The average watts dissipated by electrolytic hysteresis at the carbon and aluminium plates at 98·5 periods per second, fig. 2, are 0·69 and 4·5 respectively. This takes no account of the resistance of the electrolyte, and has been obtained by taking instantaneous products of potential and current at 20 equal intervals during the period. During the first half period work is supplied at the carbon plate on the average at the rate of 4·1 watts; during the second half period the plate does work on the system at the average rate of 2·7 watts. The aluminium plate returns practically nothing to the system.

In fig. 3, the frequency is 101, the ratio of the maximum coulombs in the two halves of the period is 1·7, and the Siemens dynamometer in the circuit registered 20·6 amperes. The average temperature during this experiment was about 55° C., but had a maximum of 64° C., at the end of the test. Under these conditions, evaporation of the electrolyte was rapid. The experiments on the resistance of the electrolyte at this frequency and temperature give 0·033 ohm, and

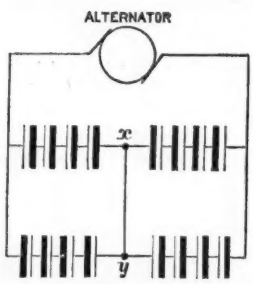


FIG. 4.

the potential curves have been corrected, the result being shown by the dotted lines. The average rate of dissipation of energy due to electrolytic hysteresis at the aluminium plate during the period is 153 watts, whereas at the carbon plate this rate is only 9·8 watts. We see that the maximum volts during the half period when the maximum coulombs are a minimum have risen to 13, whereas during the other half period the maximum volts are only 7½.

The paper by Graetz already alluded to, deals with alternate currents; and two groupings of cells with aluminium plates as the one electrode are given, whereby he proposes to rectify alternate currents. He gives 22 volts as the potential an aluminium cell is capable of opposing, and states that the current could not be measured with a delicate galvanometer. The first grouping of these cells consists of placing between the poles of the alternator two circuits in parallel, in each of which he places four cells in series. The poles are reversed so that in the one circuit the predominating current will be positive, whereas in the other it will be negative. The other grouping of these cells is shown in fig. 4, and the author states that he gets a unidirectional current in the circuit $x\,y$. In this circuit he has operated a direct current motor, and deposited copper. By superposing one of the current curves in figs. 1, 2, or 3 on the same curve, but with reversed phases, one can form an idea as to what the resulting current would be in the circuit $x\,y$. Curves in fig. 5 were obtained by observing the instantaneous value of the potential difference between the ends of a non-inductive resistance of 0·349 ohm, forming the circuit $x\,y$, fig. 4. Four small cells were used, each one taking the place of the group of four in the diagram; each of these consists of a thin aluminium sheet and a carbon plate, the opposed surfaces in a saturated alum solution having each 10 square inches, separated by a distance of $\frac{1}{32}$-inch. In fig. 5, curve I., is the current in $x\,y$, when the current from the alternate current machine through the system was 3·96 amperes, as given by a Siemens dynamometer. Curve II. is the current in $x\,y$, when the Siemens dynanometer read 10·4 amperes. The frequencies were 74 and 73·3, and the temperatures of the cells 25° C. and 44° C. respectively in the two experiments. Graetz states that with cells of sufficient size 93 to 96 per cent. of the energy of the alternate current can be changed into direct current. The efficiency of such a system as shown in fig. 4 will obviously be the ratio of the rate at which work is done on $x\,y$ to the rate at which work is done on the whole system by the alternate current machine. If this is to be 95 per cent., then only 5 per cent. must be dissipated in the cells.

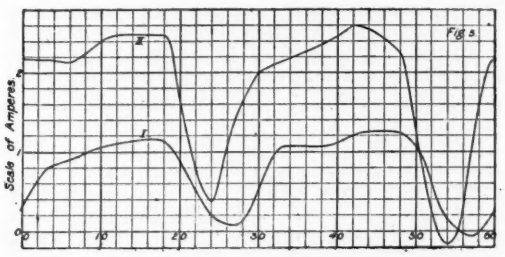


FIG. 5.

An important point in connection with the working of these cells is the wearing away of the aluminium. The thin metal used in the small cells above alluded to is perforated with small holes, but I have not noticed so much deterioration in the thicker sheet. The evaporation of the electrolyte is another matter which needs consideration if the temperature is raised fairly high in working.

Two Aluminium Plates in Alum Solution.

These experiments were undertaken to find what effect as a condenser this metal with its film has with varying frequency, temperature, and current. The aluminium plates in the two large cells above experimented upon were opposed to one another in a saturated alum solution. The distance between them was $\frac{1}{32}$th inch, and the opposed areas in the solution are 36 square inches on each plate.

The important data have been collected in Table V. As a comparison two plates of ordinary sheet iron of the same area and the same distance apart as in the aluminium cell were placed in a saturated solution of alum and placed in series with the aluminium cell. As before the circuit included a Siemens dynamometer and non-inductive resistance, and potentials were observed for different positions of the phase across the non-inductive resistance, and each cell, by aid of a Kelvin quadrant electrometer and revolving contact maker. On account of the irregular wave form of the curves of potential and current, the ratio per period of the energy returned to the system by the cell to the energy supplied to the cell, is given as a percentage. If the electrolytic process were perfectly reversible, we should expect the curves of current and potential to have a phase difference of one quarter period, if they were sine curves. An examination of Table V. shows that maximum phase difference develops with the smaller currents at lower temperature. In experi-

TABLE V.

Experiment.	Frequency.	Max. volts across one cell.	Max. amperes.	Current $\sqrt{\text{mean}}$, as given by Siemens dynamometer.	Temperature.	Ratio of energy returned to energy supplied per period per cent.	Average phase difference. 360° = one period.	Average rate of dissipation of energy in cell.	Plates.
				Amps.	°C			Watts.	
(a)	96	25·0	30	21·6	82	..	12°	...	Al
,,	,,	3·35	,,	,,	24	..	9	...	Fe
(b)	17	46·0	8	3·98	53	0·72	12	150	Al
,,	,,	1·3	,,	,,	11	...	60	..	Fe
(c)	100	52·5	2·6	1·3	14	16·0	54	42	Al
,,	,,	0·25	,,	,,	9	...	...	..	Fe
(d)	92·4	21·0	1·48	..	11	11·2	60	9·24	Al
(e)	92·4	8·0	0·51	..	13½	16·6	57	1·11	Al

ment (c) the maximum amperes are 2·5, the maximum volts 53. The curve of potential difference has a maximum rate of change of about 57·5 volts in $\frac{1}{800}$th second, so that an ordinary condenser with maximum current 2·5 amperes would have a capacity of about 72 microfarads. We see, therefore, that aluminium is suited for the plates of condensers. The average watts in Table V. have been deduced from the instantaneous product of potential and current at 20 equal intervals during a period.

The foregoing experiments employed saturated potash alum solution as electrolyte. The following experiments deal with soda, ammonia, and potash alums, first when the solutions were saturated, and second when non-saturated. In each of the non-saturated solutions the proportions were 13 parts of saturated solution at about 12° C. by volume and 70 equal parts of distilled water. Three cells were constructed, each containing two aluminium plates of 99·5 per cent. purity, separated ¼-inch apart, and each having 33 square inches of surface in the electrolyte opposed to the other. The results of the experiments are given in Table VI.

Table VI.

Frequency.	Max. volts across one cell.	$\sqrt{\text{mean}^2}$ as given by multicellular voltmeter across the three cells.	Max. amperes.	$\sqrt{\text{mean}^2}$ as given by Siemens dynamometer.	Temperature of cell in degrees Centigrade.	Ratio per period of energy returned to energy supplied to cell per cent.	Average phase difference, 360° = 1 period.	Average rate of dissipation of energy in cell.	Alum solution in cell.
		Volts.		Amperes.			Deg.	Watts.	
33	16	...	1·73	0·79	15	25·5	78	3·6	Soda, saturated solution.
"	34	...	2·17	1·03	19	2·5	31	26·2	Ammonia "
"	41	...	"	"	19½	2·7	31	25·3	Potash "
54·6	37·6	...	1·87	1·12	25½	8·7	44	22·0	Soda "
"	42·5	...	"	"	19	17·3	36	24·0	Ammonia "
"	39·7	...	"	"	19	4·3	30	28·0	Potash "
7·5	39·7	90	0·525	...	14	7·6	57	9·1	Soda "
"	48·5	91	0·95	...	15	2·8	48	23·0	Ammonia "
"	42·9	"	"	...	15½	1·9	36	21·0	Potash "
10·5	31·3	88	0·66	...	13½	3·2	41	5·0	Soda, non-saturated solution.
"	49·1	92	0·685	...	15½	4·0	48	10·3	Ammonia "
"	44·4	"	"	...	16	2·6	36	10·0	Potash "
43·2	35·0	89	0·894	...	15	26·0	70	6·0	Soda "
41·3	47·6	"	"	...	17	22·0	71	9·6	Ammonia "
"	45·0	"	"	...	17½	14·0	65	11·1	Potash "
18·5	57·8	120	2·61	1·25	16½	2·0	36	42·4	Soda "
18·1	55·7	117	"	"	21	2·1	33	39·4	Ammonia "
"	43·8	"	"	"	20½	1·4	28	37·6	Potash "

With regard to the saturated solutions, one may say that at the low frequency 7·5, Table VI., the results are not so good as at the high frequency 92·4, Table V. The non-saturated solutions also show a better result with regard to efficiency at the higher frequency.

These plates were not specially formed with direct currents and carbon cathodes before starting the above experiments. In a preliminary experiment of about one hour's duration before the first series at frequency 33 in Table VI. were made, and starting with clean polished plates, the maximum volts for the soda, ammonia, and potash were, a few minutes after starting, 4·4, 21·5, and 32. The maximum current was 0·48 ampere, and the phase differences in each case about 70°. The frequency was 23 and the temperature of each cell about 14° C.

An experiment was tried in which two aluminium discs 6 inches diameter and separated $\frac{3}{16}$ths inch on an ebonite spindle were submerged to within ¾ inch of the centre in a saturated potash alum solution and rotated at 108 revolutions per minute by a small electric motor. In this manner more than half the discs were continuously exposed to the atmosphere. Two brushes bearing on copper discs, pressed into good contact with the aluminium discs, served as a means of transmitting current through the electrolyte between the discs. The frequency was 73, the temperature 18° C., and square root of mean square value of current about 1 ampere. No perceptible difference was observed in phase difference between potential and current when the discs were rotated and at rest in the electrolyte.

The conclusion is that the effect investigated in this paper takes time to develop, and is not fully developed with alternate currents of frequencies 16 and 98 complete periods per second. It can be increased by increasing the current density for a given film, and is greatly influenced by temperature. The metal aluminium with its film is suitable for use as the plates of condensers, if due regard be given to current density and temperature. It might in some cases be found useful as an equivalent to a metallic resistance.

Messrs. Simpson, Greenbank, and Davy, student demonstrators in the Siemens Laboratory, King's College, London, have given me valuable assistance in the experimental part, and in the working out of results. To these gentlemen I tender my thanks.

THE EIGHT HOURS' DAY.

The *Times* correspondent in Sunderland writes a description of a several years' experiment which has been made by Messrs. Short Bros., the shipbuilders, of Pallion. This firm has been working the eight hours' day since 1891, and the output has gradually increased since then, but they have made nothing public, preferring to give the system a full trial before doing so. Now they express themselves satisfied, and would not go back to the old hours. The present hours are from 7.30 a.m. to 5 p.m., with one break. We have no doubt this is possible in the country, but under present conditions it cannot be done in London. The writer tried the system in his own shop, so far, at least, as suggesting it. Every man declared that it simply meant coming by the same train as heretofore, and spending the time in the street or public house. Their workman's train would not fit in to the 7.30 start; their missuses would not get them their breakfast at the early hour, and they could not work from 7.30 to noon without a break, after so early a breakfast. They would not even come to the shop and breakfast from 7 to 7.30 and then start, and the only result of the eight hours' day was to reduce output, make every man discontented and idle, help the public houses considerably, and upset everything.

If the eight hours' day is ever to be a success in London, it will only be with the co-operation of the railways. Already over-crowded, can they deal with the 7.30 men and the other men and women who are now arriving at work at 7.30; and if they can is there a railway board who will consent? People who talk of changed hours forget the imbecility of most of our London railroad managers.

A sensible article in the *Engineer*, commenting on the *Times* article, asks pertinently why the number eight, or any other number, should be used as a fetish, or to this effect? What may be good for a shipyard in a bleak East Coast winter, may be quite unsuitable for a Birmingham workshop, perhaps well warmed and lighted, and full of machines which require very little attention and cannot turn out as much in eight as in nine hours. There must be a best length of day for every place. It may be seven hours in one place and ten in another. Brunner, Mond, Limited, who work 24 hours a day, found that three shifts of eight hours cost them less in wages per unit of product than did two shifts of men of 12 hours each. This proved eight to be better than 12 hours in that works, but it did not prove eight hours superior to, say, nine hours. But a nine hours' day would be inconvenient in a works making a total of 24 hours, as it would change the starting hour of each shift every shift.

In a shop doing a regular mechanical business it might be possible to show that the best length of day was 8 hours 47 minutes, but the best length would alter continuously. An over-hot day might well be shorter than one of ordinary temperature, and the expense of winter lights might well be a reason for shortening the day below the length of summer days, and so on. Changes cannot be made in this way. There must be a fixed day of some length, though we can well imagine that the best practice in England would be to have longer hours in summer than in winter, making the change at the two equinoxes, and reducing the bill for winter lighting, while affording a relief from the early morning rising in the dark, on the one hand, and giving time in the evening for those who attend classes, as well as for other winter relaxations. The whole controversy about hours of labour reminds us very much of the episode related by Gulliver anent the opening of eggs at the large or small end. A war resulted, about as sensibly as the late engineers' strike, the curious thing about which was that it occurred in London, or over the attempt to foist the eight hours' day upon London which did not want it, and could not have done with it comfortably for reasons above detailed if it had got it. It would have been a good thing if the hours' question could be set free from the trammels of any specified number of hours.

As stated in the *Engineer*, it is not the nominal day which measures the hours worked, but the amount of time devoted other than to rest-

ing. The smith's striker does not strike all the time. He stands idle full half or three-quarters of the day, for he could not work the day through without these intermissions. Similarly the domestic who begins her day by spoiling your breakfast at 8 a.m., and finishes by breaking the best china at 8 p.m., has not worked the enormity of 12 hours with which such as John Burns credits her. Part of the time she has spent on a penny dreadful, and part in abusing you to her friend next door. Relief from a fixed day would possibly clear the atmosphere and demonstrate to many thousands of people that work and hours cannot be measured out to fit all men alike.

THERMAL EFFICIENCY OF STEAM ENGINES.

I.

In 1896 the Council of the Institution of Civil Engineers appointed a committee to consider and report upon the subject of the definition of a standard or standards of thermal efficiency for steam engines. There are two obvious standards and modes of stating efficiency. One is the ratio between the heat converted into work and the total heat supplied, and this ratio may have two forms according as it includes the heat given to the engine or that contained in the fuel.

In this system of stating efficiency there can be no unity, for we know it is impossible to utilise all the heat supplied to an engine even in a perfect and frictionless engine. The second system is that of comparing an engine with a perfect engine whose maximum efficiency is limited by the law whose expression is $E = \frac{T_1 - T_2}{T_1}$.

To render clear what losses a steam plant is subject to a graphic diagram is included which shows the heat generated on the firegrate in the form of a broad stream from which definite proportions of its breadth are taken off by various smaller streams marked to indicate their direction, such as "flue loss," "radiation from boiler," and so on, and other streams return from the various sub-streams and rejoin the main body, thus indicating where a heat return is made, as by the hot-well feed, the economiser, &c.

The report deals with the steam engine proper, and this is defined as coming between the boiler side of the stop valve and the exhaust flange. Taking the celebrated Leavitt pumping engine, owing to its fully tabulated data and results, the graphic diagram shows that out of 183,600 heat units produced on the grate per minute, 131,700 go into the water direct; 10,000 are lost by radiation and leakage, and 41,900 pass to the flue gases. Of this 1,000 units disappear on the way to the economiser, 5,000 are lost by radiation from the economiser, 15,750 are returned to the feed water, and 20,150 go off as waste in the chimney. The feed water carried 5,450 heat units to the economiser, and thus there were 21,200 heat units delivered from the economiser to the main stream, of which only 20,950 reaches the boiler, the remainder being lost in transit. In the boiler there is added to this a second return stream of 6,600 from the jackets. The steam which comes from the boiler derives heat therefore from three streams, and finally leaves with 159,250 B.T.U. per minute. Of this it loses 3,100 by steam pipe radiation and leakage, and the heat supplied to the engine is thus 156,150 units per minute gross. On the assumption that the exhaust steam is practically able to raise the feed to the exhaust temperature some 7,400 units may be credited to the engine although the actual return to the boiler is less, being only 5,450, but this is due to an excess of circulating water lowering the condenser temperature below that due to the pressure. The difference 1,950 is to be debited to the feed and condensing gear, not to the engine proper. The engine is also allowed a special credit of 6,750 units in the shape of jacket condensation returned to the boiler or 6,600 net. The net amount only is credited to the engine because the jacket is an appurtenance of the engine for its benefit. The net engine supply of heat is thus 142,150 units and only 27,260 are utilised as work on the pistons. The ratio is the thermal efficiency of the engine as usually understood, though the late Mr. Willans used the term to signify the ratio of an actual to an ideal engine. In the present case the efficiency is 0·15, and the heat per I.H.P. minute is 221 B.T.U., the I.H.P. being 643. The figure 221 is what the report calls the thermal economic value of the engine with a view to replacing the term water per I.H.P.-hour. Engine friction absorbs 1,870 B.T.U. The B.H.P. is 599, and $\frac{142,150}{599} = 237$, a figure the Committee recommend to be quoted in ascertaining brake efficiency. Assume now an ideal engine on the Rankine cycle (a Rankine cycle assumes a perfect plant, and no initial condensation, leakage radiation or conduction, and no clearance, a feed at the exhaust temperature, and dry saturated steam, a level admission line on the indicator diagram, and adiabatic expansion down to back pressure with a level exhaust line at that back pressure) working at the same I.H.P. as the actual engine and the same initial and final temperature, viz., 359° and 100° F. It is then shown by another diagram that this ideal engine has a gross heat supply of 100,900 and returns 5,600 units in the feed. Its net heat consumption is 95,300 units per minute. Its thermal efficiency is thus $\frac{27,260}{95,300}$ or 0·285, equal to 148 units per I.H.P. as against 221 in the actual engine.

The ideal engine thus becomes the Committee's standard of comparison, and the "efficiency ratio" is 0·67, or $\frac{148}{221}$, which is what Mr. Willans called the thermal efficiency, and Prof. Osborne Reynolds called it the percentage of theoretical efficiency.

The work of the Committee can thus be stated briefly as a recommendation to state efficiencies and values in terms of B.T.U. per I.H.P. per minute, and in directing how these values should be found.

(To be continued.)

HAWTHORN (VICTORIA) ELECTRIC LIGHTING SCHEME.

The following is taken from a report of the Electric Lighting Committee of the City of Hawthorn, Victoria:—

The system which found most favour with the expert advisers of the committee is the alternating high tension transformer system, the arc and incandescent lighting being on the one circuit. In the Alcock Co. and City Council's works the arc lighting is on a direct current circuit, and the incandescent lighting is on a separate circuit.

The pressure is 2,080 volts at no load, and 2,300 volts at full load, and the total output of the plant is 180 kilowatts. The following is the approximate capacity of other electric lighting works in the colony:—

A. U. Alcock Co.	455 kw.
New Australian	980 kw.
Melbourne	819 kw.
Ballarat...	96 kw.
Bendigo	75 kw.
T. Draper & Co.	420 kw.

The Hawthorn plant comprises:—

3 Boilers, with pumps, water heaters, &c;
3 Engines;
3 Alternators and exciters;
8 miles of cable (lead and return);
50 Arc lights of 2,000 C.P. nominal for street lighting, and an equivalent of 40,000 8-C.P. incandescent for private lighting. The necessary transformers, ampere and voltmeters, switchboard, and all accessories are provided.

Tenders.—On June 24th, 1898, the committee received 15 tenders from 10 firms. The details accompanying each tender are very voluminous, some individual tenderers giving 30 type-written pages of foolscap and supplying a large number of plans, all of which are open for Council's inspection. Before coming to a conclusion which tender to recommend the Council for acceptance, the committee visited all the electric lighting undertakings in the metropolis and received a good deal of useful information. All the stations have adopted the belt connected plant throughout, save the Alcock Company, which has two large alternators direct coupled. After several meetings and much consideration of the various tenders, the committee unanimously agreed to recommend for acceptance the tender of the General Electric Company, of New York. The plant proposed by this company is belt connected, and a general description is here given:—

Boilers.—The boilers are of the Babcock and Wilcox type, each of 100 H.P. arranged in one battery of two boilers and one boiler separately. The total heating surface of the three boilers is 2,674 feet, and the grate area 80½ feet. Each boiler has six sections, composed of six best lap-welded wrought-iron tubes, 4 inches diameter and 18 feet long. They are to work at 150 lbs. pressure to the square inch, and will be tested when erected at 50 per cent. above working pressure. The space occupied by the three will be 23 feet long, 19 feet 2 inches wide, and 13 feet high to top of steam opening. A full set of tools are also supplied. The committee found this type of boiler in use at the New Australian and Melbourne City works, and from evidence received believe them to be the most efficient boilers that can be had, though they are higher in first cost than the ordinary shell boiler.

Water Heater.—In order that the boilers may be supplied with water at a temperature to give an economic coal consumption a water heater is provided, guaranteed to raise the temperature of 90,000 gallons of water per hour from 32° to 200° F., and to do this the waste steam is used. The apparatus consists of 60 brass tubes, 1¼ inches external diameter and 62¾ inches long. These tubes are fixed vertically in a cast-iron cylinder 20½ inches external diameter, through which the exhaust steam passes and raises the temperature of the feed water as it flows through the tubes to the boiler.

Pumps.—The feed water pumps are G. F. Blake & Co.'s make, and will deliver 1,512 gallons per hour.

Steam pipes are to be of cast-iron, properly flanged and bolted together, and fitted with a copper expansion joint and all necessary steam and sluice valves.

Smoke Stack.—The smoke stack is of $\frac{3}{16}$-inch steel plates, 70 feet high and 54 inches in diameter. The flue will be lined with fire brick, and have a sectional area of 13 feet. The tenderer undertakes that the whole of the boilers, &c., shall be of first-class workmanship, and will be erected in a substantial manner.

Engines.—The engines are built by McIntosh and Seymour, and will be of the horizontal tandem compound non-condensing centre crank type, with 12 inch stroke and 275 revolutions per minute, at an initial steam pressure of 120 lbs. per square inch. The diameter of the fly-wheels is 4 feet, and the face 12½ inches. The mechanical efficiency is guaranteed at 92 per cent. The speed will not vary more than 2 per cent. from no load to full load. The high pressure cylinder will be steam jacketed. The valves are provided with a patent adjustable seat to prevent leakage. The

governor which drives the cut-off valves consists of centrifugal weights, which vary the point of cut-off by revolving the governor eccentric upon the staff, and are very efficient; in fact, this governor can be adjusted to give practically perfect regulation without any tendency to race under a widely fluctuating load.

Alternator.—The alternator will be manufactured by the tenderer, and will be of the single-phase type of 60 kilowatts capacity, with eight poles. It will give a current of 60 cycles periodically, at 2,080 volts no load and 2,300 volts full load. The armature core is built up of sheet iron of high magnetic permeability, 014 inch thick, each piece being japanned and kept apart from the adjoining piece by sheets of paper, to prevent eddy currents. The windings will be slotted into the circumference and held firm by wooden wedges. Provision will be made in the armature for allowing free circulation of air in direct contact with the core and windings. The windings will be insulated to withstand 5,000 volts before being placed in the machine. The armature speed will be 900 revolutions per minute. The armature will be tested to 5,000 volts alternating, and no part of the machine will rise in temperature more than 40° C. above the temperature of the surrounding air after 10 hours' run at full load.

The efficiencies will be:—

Full load	90·5 per cent.
Three-quarter load	89·0 " "
Half load	86·0 " "
Quarter load	77·5 " "

The total weight of the machine will be 7,600 lbs. All the parts will be made to gauge, and will be interchangeable.

Exciters.—There are to be two exciters, any one of which will furnish the necessary current to excite all three of the alternators. They will have two poles and be of 4½ kilowatts capacity at 125 volts, at a speed of 1,100 revolutions per minute.

Switchboard.—The switchboard will consist of six panels of polished blue Vermont marble, and will weigh 2½ tons. There will be one exciter panel, three generator panels, and two feeder panels. Each panel will be fully furnished with ammeters, voltmeters, switches, synchronising switch, transformers, safety switches, and lightning arrester. The switches and instruments are of burnished brass and copper. The high tension switches are fully protected from accident to the attendant, because the contacts are made at the back of the panel. The tenderer terms it a "safety board in every sense."

Transformers.—The transformers are of the oil type, and in some instances are larger than those mentioned in the specification. They are tested to 10,000 volts between the primary and secondary windings.

The guaranteed efficiency of the transformers will be as follows:—

Rated output.	Efficiency at full load	Efficiency at ¾ load.	Efficiency at ½ load.	Efficiency at ¼ load.	Efficiency at $\frac{1}{10}$th load.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
600 watts ...	93·7	93·2	91·7	86·7	72·5
1,500 watts ...	95·3	95·1	94·5	91	80·5
4,000 watts ...	96·3	96·3	95·7	93·2	85·5
7,500 watts ...	96·8	96·6	96·3	93·9	86·8

Each transformer will be supplied with a primary switch and fuse box in a neat iron case with glass front.

Arc Lamps (50).—These are of the *enclosed long burning type*, and will give from 80 to 100 hours' of light with one trimming of a new 9½-inch carbon. Each lamp has its own attached transformer. It is claimed for the enclosed arc lamps that they will require 12,000 carbons per year less than the open type, and cost considerably less in attention. They consume from 430 to 450 watts, and can be adjusted to operate on circuits varying from 100 to 120 volts.

Underground Cables.—Two proposals are submitted, one contemplating *high tension* mains only, from which wires will be led to transformers conveniently situated on the premises of the consumer. The other scheme involves a secondary *low tension* main in addition to the *high tension main*, both of which are laid in the same trench, the high tension extending the full length of the streets, and the low tension extending three-quarters (¾) of a mile each way from the Town Hall, assuming the generating station to be near thereto.

The advantage of the low tension main is that transformers are not required, and service lines can be taken off at any place just in the same way as gas pipes are taken from the main.

The prices are as follows:—

No. 1 Proposal—

High tension mains only ...	£1,024 10 0
Connection boxes, 100 ...	137 0 0
	£1,161 10 0

No. 2 Proposal—
Low tension main, £317 10s. additional.
Total, £1,479.
Add for laying say £180 in both cases.

To carry service lines from mains to consumers' premises is approximately estimated at £238 in either case.

Comparing with overhead, the tenderer submits the following:—

Cable as per tender. 5 miles 7-16 ...	£210 10 0
" " 3 " 7-18 ...	156 15 0
600 oil insulators	132 10 0
130 poles, erected	438 15 0
Crossarms	97 10 0
Painting	65 0 0
Scheme No. 1—Underground ...	£1,341 10 0
Scheme No. 2—Underground ...	£1,659 0 0
Scheme No. 3—Overhead ...	£1,101 0 0

Proposal to Run the Plant.—The tenderer offers to operate the plant for three years, but finds a difficulty in fixing a price that will be alike fair to the Council and himself. He therefore proposes to be paid for a minimum consumption of 176,000 units, and he estimates the cost of producing this quantity to be £1,248 a year, or 1·7d. per unit. The profit the contractor looks for is about £600 a year, for he requires to be paid 2·45d. per unit on a minimum of 176,000 units. The committee has not recommended this part of the proposal for acceptance by the Council, because the price is considered too high, and the committee is of opinion that the Council can operate the plant at a much less cost. The estimates mentioned in the earlier part of this report are:—

Mr. Arnot	£1,510
Mr. Stuart	1,424
Mr. Lockley	1,404
Tenderer	1,248
Fair average ...	£1,396

Let it be assumed that £1,400 is a fair working estimate; add for interest and sinking fund on capital £10,000, 6 per cent., £600; which gives a total annual outlay of £2,000.

In order to recover this amount the following must result—

Approximate saving in gas ...	£200
72,000 units privately consumed ...	1,800
	£2,000

The question for consideration is what probabilities are there that 72,000 units will be taken. One unit will provide energy for one 16-C.P. light for 16 hours. Assume an average of 4 units per week per house at 6d.—2s. a week. The large shops and hotels will take much more. 348 consumers at 2s. a week, £1,800—the amount required. Mr. Vasey, in his letter to the Council last meeting, stated the average charge to private consumers for May was 8s. 6d. The Council will notice the committee's estimate is below this figure. The question now arises—Are 348 consumers available? It must be remembered that there are approximately 550 buildings within the area of supply, *excluding* all those having less than six rooms, and

Full List of Tenders.

	Westinghouse.		Gibson, Battle & Co.	General Electric Co.	Crompton & Co.	Siemens.	Slater & Co.	Brush Co.	Austral Otis	Johnson & Phillips.		
	No. 1.	No. 2.								No. 1.	No. 2.	No. 3.
Boilers—complete ..	£2,859 4 3	£2,586 12 3	£1,587 0 0 Colonial, or English— 1,887 10 0	£2,249 10 0	NIL.	£3,090 0 0	NIL.	£1,860 0 0	£1,857 0 0	£1,701 0 0	£2,082 0 0	£1,701 0 0
Engines ..	£1,310 13 0	£1,096 3 0	BULK SUM.	£1,785 0 0	£2,253 0 0	£2,188 0 0	£1,874 8 0	£1,752 0 0	£1,686 9 0	£1,182 0 0	£1,433 0 0	£1,433 0 0
Alternators ..	1,135 4 6	862 2 10		1,044 0 0	1,600 19 0	2,379 0 0	2,263 16 0	2,112 0 0	1,921 19 0	1,650 0 0	1,274 0 0	1,274 0 0
Switchboard ..	320 7 6	320 7 6		540 10 0	335 0 0	520 0 0	641 6 0	636 0 0	208 19 0	480 0 0	480 0 0	480 0 0
50 arc lamps ..	549 14 6	549 14 6		837 10 0	725 0 0	662 10 0	996 17 6	656 0 0	575 0 0	715 0 0	715 0 0	715 0 0
8 miles cable ..	718 7 10	718 7 10		867 5 0	528 19 0	565 0 0	554 8 0	378 0 0	718 14 0	613 0 0	613 0 0	613 0 0
Sundries ..	1,159 12 9	964 17 9		1,416 12 6	3,987 2 0	2,622 15 0	3,419 4 6	2,536 17 6	2,579 5 6	1,689 0 0	1,683 0 0	1,683 0 0
	£5,194 0 1	£4,511 13 5	£10,134 0 0	£5,990 17 6		£8,882 5 0		£8,070 17 6	£7,690 6 6	£6,329 0 0	£6,208 0 0	£6,208 0 0
Totals ..	£8,053 4 4	£7,098 5 8	£11,731 10 0	£8,240 7 6	£9,480 0 0	£11,972 5 0	£9,750 0 0	£9,930 17 6	£9,547 6 6	£8,030 0 0	£8,290 0 0	£7,909 0 0
	Delivered.	Delivered.	Delivered.	Erected.	Erected.	Erected.	Erected.	Erected.	Erected.	On Ship at British Port.		

from inquiries made the committee has every reason to believe that their anticipation will be realised.

There are 267 dwelling houses, 9 hotels, 242 shops and offices, 5 banks, 4 churches, 6 public buildings, 1 coffee palace, 3 railway stations.

The committee therefore recommends the Council to accept the tender of the General Electric Company, subject to such detail modifications in the specification as may be necessary.

THE BRITISH ASSOCIATION DISCUSSION ON MOTORS.

Prof. Silvanus Thompson, in opening the discussion on electric motors, immediately plumped for alternating current work. If they looked all over the world, by far the greater proportion of machinery was being driven by alternating currents. Traversing one of Mr. Siemens statements that "alternating current motors refused to start without being synchronised," the Professor said that may have been true 10 years ago, but it was not true to-day. Another statement of Mr. Siemens that where power was wanted for short intervals, no economy could be effected by electricity, was controverted by the speaker instancing the case of the electric bell and the electric crane. Turning to Mr. Gibbings's paper, Prof. Thompson complained of it as giving a one-sided set of statistics; he had suppressed all the data on the other side, *i.e.*, relating to alternating current motors. The City of Frankfort, which had an alternating current station, had more motors on its circuits than Liverpool and Manchester put together. They did not in this country realise what motor work was, because they were sticking to the continuous current. Why should all the Swiss installations be equipped with alternating current machinery? They had no patents in the way of continuous currents; they adopted what was best, and the result was that they had three-phase machinery going ahead in that country, and we in this country were told that alternating currents were being considered. He would refer Mr. Siemens to the case of a factory in Switzerland which had been equipped throughout with continuous current motors. Last year the whole of these continuous current motors were taken out and three-phase substituted. For the benefit of people in Bristol the speaker pointed out that Ballé, the Swiss shoemaker, had, for years, endeavoured to compete with the shoe factories of Bristol and Leicester. Four years ago they substituted for their steam machinery electric power on the two-phase alternating system, and now they could compete commercially with Leicester and Bristol owing to the cheapened production of their factory.

Mr. T. Parker then appeared on the other side and immediately closed with the statements of Prof. Thompson. The most prominent feature of Prof. Thompson's address, said Mr. Parker, was his ignorance of what had been done in his own country. His firm, for 3½ years had been mainly employed in the construction of power plant on the direct current principle, and these plants were being put up not only in this country but all over the world. He had had to substitute in one case continuous current plant for three-phase to give constancy in working. For varying loads, or where extra powers were required, three-phase plant could not compare in economy with continuous current. Referring to Mr. Geipel's paper, the author had laid stress upon the absence of commutators, also that the three-phase motors could be left running with considerable overload; those were general statements, and were liable to give erroneous impressions, because nothing was said as to what they could do with continuous currents.

Mr. Faraday Proctor endeavoured to clear away a misunderstanding that had arisen with regard to the intermittent use of electricity for machinery. When electricity was supplied from public mains the great advantage to a consumer was that he could use his power intermittently. Mr. Siemens was probably referring to the case of a user generating his own power.

Mr. Baily thought that some little experience was necessary in supplying power and lighting from the same dynamos, and it was probably not worth while to risk the lighting. Mr. Siemens's figures relating to cost were interesting, because the problem frequently before them was whether to make electricity yourself or go on the town for it.

Mr. W. H. Preece spoke of the various uses of motors that were made in the Post Office. After referring to the unfair use of monopoly that was occasionally made, Mr. Preece spoke of the adoption of electricity on the underground railways in London. The boards of the companies had decided to use electricity, and experiments were about to be started to determine which was the best system. Every firm would have an opportunity of laying different schemes before them, and it would be the best system that would win, whether it was the three-phase or direct current. Mr. Siemens had not told them how they protected the overhead lines in power transmission against lightning. In one system with which he was connected he had surmounted the line carrying current with barbed wire and he had reason to believe it had proved beneficial. To a local authority the load occasioned by the supply of motive power was of the greatest consequence. By Act of Parliament they had to maintain pressure on the mains the whole of the 24 hours, and if it were possible to use motors during the day sufficient to pay the working costs of the useless loads it would thereby enable them to reduce the price of light. In Bristol there was a great question some time ago as to whether the current should be supplied to the tramways from the Corporation mains, or whether the Tramway Company should supply themselves. If they could have come to terms the local authority could have reduced the price of electricity to the community 1d. per unit.

Mr. Alexander Siemens, in replying to the criticisms raised, said that Prof. Thompson had overlooked the fact that he (the speaker) was closely connected with a German firm who had made three-phase work a speciality, and they could have utilised the result of their experience. Still he stuck to the old-fashioned continuous current. He looked upon the three-phase craze as a matter of fashion. Prof. Thompson had shown that he was not a practical man by assuming that electric cranes were used intermittently; the electric crane was the one tool in a workshop that was used most of all. It was difficult to make continuous current dynamos of high voltage, but in a great many cases three-phase currents were transformed into continuous currents. He considered Mr. Geipel's figure of 2 lbs. of coal too low. In Siemens's works they had two men to look after all the motors, many of which were put on brackets on the wall, and they could be left running without any attention.

Mr. Gibbings contented himself by observing that in this country continuous current motors were the only ones used to any extent.

Mr. Geipel, in replying, said one of the reasons why single-phase alternating motors had not been adopted in this country, was that nearly everybody put in machinery suited to give high periodicities, which was a most difficult problem when they came to motors. Had they adopted 40 or 50 periods, their troubles would not have been great. He was pleased to note that all recent stations were adopting a reasonable periodicity of something like 50. Railways were already being operated by three-phase currents, and many more would adopt the system. When they came to long lines, it was admitted that the continuous current was hopeless, they were obliged to use three-phase for transmitting current, but there was no reason why they should not use three-phase motors. The difficulty of balancing three-phase lighting circuits was easily overcome. He differed entirely from Mr. Siemens when he said that three-phase was used only for transmitting; they had already several instances in this country where it was used directly for motor work. The difficulty of starting three-phase motors was less than the difficulty of starting continuous motors.

CORRESPONDENCE.

Re Pacific Cable.

I see by your issue of July 1st last, you have been good enough to refer to the article that had appeared in your Journal on May 21st last, and which I thought was so good and to the point, that I took the liberty to have it circulated throughout Australasia to all the Chambers of Commerce, he Press, and to all the Governments; in fact, I sent it to

all Governments who were interested, and their replies have been most encouraging so far as the Pacific cable and route are concerned.

But what I desire you to correct is, "*That I am representing the interests of the French Cable Company in Australasia.*"

Will you now please state that I have long since sent in officially to the French Cable Company, and to the Australian Governments, that I no longer represent the French Cable Company. My sole aim is now, as heretofore, to bring about the laying of the main Pacific cable, with Queensland as its southern termini.

Audley Coote.

Sydney, *August 16th.*

Mechanical and Electrical Exercise!

I should be obliged if any of your electro-medical readers can inform me whether it would be beneficial, or otherwise, to combine mechanical with electrical exercise of the muscles, viz., to connect the terminals of an induction coil to dumb bells or the handles of an exerciser by a flexible wire so that the contractions of muscles by the two agencies may synchronise, a slow vibrator being, of course, used with the coil.

Chas. Roberts.

Aluminium Importers.

Can any of your readers give me names of firms importing aluminium sheets from abroad ?

J. H. S.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Sept. 20th, 1897.	£	s.
Alexandria	22	0
" Teleg. mat.	13	0
Amsterdam	95	0
Bangkok	110	0
Beira	300	0
Bombay	126	0
Buenos Ayres	224	0
Calcutta	353	0
Cape Town	162	0
Cologne	42	0
Colombo	620	0
Durban	2,025	0
Lisbon	76	0
Malaga	20	0
Melbourne	85	0
Port Elizabeth	878	0
Rotterdam	56	0
Singapore	50	0
Stockholm	530	0
Sydney	685	0
Wellington	102	0
Total	£6,584	0

Week Ending Sept. 20th, 1898.	£	s.
Adelaide	1,150	0
Alexandria	20	0
Auckland	49	0
Bangkok	256	0
Boulogne	20	0
Brisbane	160	0
Buenos Ayres	697	0
" " Teleg. mat.	100	0
Calcutta	26	0
Cape Town	376	0
Chinde	1,060	0
Colombo...	102	0
Constantinople... ...	45	0
Copenhagen	95	0
Delagoa Bay	300	0
Demerara. Teleg. mat.	82	0
East London	1,053	0
Flushing	24	0
Gothenburg	79	0
Hamburg	400	0
Hong Kong	148	0
Melbourne	267	0
" Teleg. mat.	54	0
" Teleph. mat.	146	0
Paris	9	0
Rotterdam	12	0
St. Petersburg	90	0
" Teleg. mat.	71	0
Singapore	94	0
" Teleg. mat. ...	954	0
Stockholm. Teleg. mat.	215	0
Sydney	66	0
Tientsin Teleg. mat. ...	110	0
Yokohama. Elec. teleg. cable...	14,315	0
Total	£22,645	0

Foreign Goods Transhipped.

	£	s.	d.
Perth	100	0	0

Bankruptcy Proceedings.—On September 16th, upon the petition of a creditor, a receiving order was made at the Carmarthen Bankruptcy Court, in the case of H. D. McIntyre, colliery proprietor and electrical engineer, of Putney, and carrying on business at the Glanamman Colliery, Glanamman, Carmarthenshire.

Change of Address.—The offices of the Reflector Syndicate, Limited, will be removed on the 23rd inst. from 39, Victoria Street to Grosvenor Mansions, Victoria Street.

Electric Pumping at Arniston Colliery.—The directors of the Arniston Coal Company, Limited, along with a number of friends, assembled on the 16th inst. at their Gorebridge Collieries to inaugurate a large new electrical pumping installation which has just been completed there. The new pumping apparatus is electrical, and the plant now fitted up at the Arniston Collieries by Messrs. Ernest Scott & Mountain, Limited, Newcastle-on-Tyne, is said to be the largest installation of electric pumping machinery in the United Kingdom. Two steam engines, of the horizontal, compound, long stroke type (by Robey) are provided for driving the dynamos, each engine being fitted with cylinders of the following dimensions:—Diameter of high pressure cylinder, 16½ inches; diameter of low pressure cylinder, 26½ inches; length of stroke, 36 inches; approximate revolutions per minute, 84. Each engine is capable of giving 350 indicated horse-power with 120 lbs. steam pressure when working condensing. The boilers, which are located outside, are of the Lancashire type. Each boiler is 30 feet long by 8 feet in diameter. There are two dynamos of the latest and most improved type, fitted with drum bar armatures, each dynamo being constructed to give the following output:—Total watts, 200,000; amperes, 363; volts, 550. They are designed for continuous running. Each dynamo is 14 feet long, 4 feet in width, 9 feet in height, and weighs about 20 tons. They make about 400 revolutions per minute. The main switchboard, placed on one of the walls of the power station, is so designed that the current from one or other of the dynamos, or from both combined, can be used to meet any contingency caused by the breakdown of any part of the machinery. The heads of the Emily and Gore pits are about 1,000 yards apart. The pumps provided to keep the mine dry are as follows:—One set of Scott & Mountain's improved mining pumps of the three-throw type, fitted with rams 11 inches diameter by 18-inch stroke, at the Gore Pit bottom, to deliver 500 gallons per minute against a head of 678 feet; one set of pumps similar to the above at the Emily Pit bottom, with rams 11 inches diameter by 18 inches stroke, to deliver 500 gallons per minute against a head of 256 feet through 3,175 feet of cast-iron pipe. Both of the above pumps deliver through pipes 10 inches diameter, tested by hydraulic pressure to 400 and 500 lbs. per square inch; three sets of pumps in the dook, each set being capable of delivering 100 gallons per minute against a head of 450 feet—these pumps deliver through 1,200 feet of cast-iron pipes 6 inches diameter. In association with each pump at these different levels there is, of course, one or more electrical motors which transmit their power to the pumps by driving belts. For driving the large high-lift pump, which delivers 500 gallons against 678 feed head, two 80-horse-power electric motors are provided, the speed being approximately 450 revolutions per minute. These motors are coupled together, and are constructed so that the armatures will be interchangeable with the single 80 horse-power motor for the low lift pump. The second set of pumps are driven by a single motor of 80 horse-power, which also runs at a speed of approximately 450 revolutions per minute. The three sets of 6 by 9 pumps are driven by electric motors, each capable of giving 25 effective horse-power when running at a speed of approximately 750 revolutions per minute. The current from the main switchboard is taken to a distributing board at the pit bottom by four cables, each about 400 yards in length. This cable is composed of 37 wires, No. 11 S.W.G., and is heavily insulated with vulcanised India-rubber and armoured all over with steel tape. The object in having four cables is to enable the installation, under ordinary circumstances, to be divided into two circuits. If required, they can all be coupled together, or in the event of any accident happening to any cable, the remaining cables being connected up, the pumps can still be run. The current from the distributing board at the pit bottom is conveyed to one 500-gallon pump by two lengths of cable, each 1,130 yards long, or a total of 2,260 yards, composed of 37 wires, No. 12 S.W.G., insulated with vulcanised India-rubber, and securely cleated to the uprights along the main road. Another branch is taken from the main distributing board to the four 100-gallon pumps. These cables are composed of 19 wires, No. 13 S.W.G. From the foot of the main dook, 500 fathoms deep, the water is raised in three lifts by the dook motors and pumps, and along the pipes described to the "sump" at the bottom of the Emily Pit. From there it is pumped by the rising road, already mentioned, along which the pipes are laid to the foot of the Gore Pit, where the two 80-horse-power motors and the 500-gallon pump send it at one lift up the Gore Pit shaft. At the top of this shaft it is discharged into the Gore burn. This installation, exclusive of the building of the power stations, has cost about £12,000. In the carrying out of the contract the Arniston Coal Company was represented by Mr. James Malcolm, general manager, in conjunction with Mr. A. A. Campbell Swinton, consulting electrical engineer.

Freight War in African Shipments.—The freights between South Africa and New York have always been against British interests, in some cases to the extent of 10s. per ton, as proved by a set of tables got out at the instance of the Wolverhampton Chamber of Commerce in 1896. The committee had no hesitation in stating that freights might be considerably reduced, so as to place English merchants in a better position as regards the more favoured shippers of Germany and America. The subsequent action of the South African Merchants' Committee and other bodies effected some improvement in the way of equalising rates, but there has now broken out a freight war in connection with steamers sailing from New York to South Africa. The American-African Line resolved to place steamers on the Australian route also, hitherto served by sailing vessels. Regular loaders for Australia looked on this as an infringement of their trade, protested without avail, and retaliated by put-

ting on steamers for Australia to coal at Cape Town, and to carry to South African ports at cutting rates of as much as 25 per cent. in cases. The American-African Line and the Union Clan Lines have resolved to meet this, and also to concede a 10 per cent. rebate to shippers giving them exclusive support. The *British and South African Export Gazette*, to whom we are indebted for this information, has taken up the matter seriously, and disposes of Sir Donald Currie's statement that the differences were inconsiderable between English and American rates. If so insignificant as Sir Donald would make believe, why cannot they be equalised, so as to stop further argument. Our contemporary complains that the differences are such as to form a serious handicap on British shippers, even before the present freight war. South Africa, while the war continues, will be flooded with American goods, with which British goods paying full rates cannot hope to compete. While not blaming Sir Donald Currie for the present freight war, our contemporary considers that an earlier equalisation of rates would have prevented it, and this is clearly his fault for having neglected it, he having too long ignored the legitimate complaints of South African merchants as to the disparity in the rates charged from New York and from London. It cannot be said that the great English shipowners have ever extended the smallest sympathy or help to English merchants. Their position almost invariably has been adverse to England. We are glad to know that such action on the part of the P. & O. Company—a subsidised line which gives much lower freights from foreign than from English ports—will be made a subject for question in the House when next the vote for the subsidy comes up.

"Household" Telephones.—Messrs. Gent & Co., of Leicester, are just introducing to the market a very handy domestic telephone appliance. Where an electric bell system already exists, it is possible by this arrangement to add the telephone service as well without the addition of extra wires. It is only necessary to have near the bell pushes, an instrument consisting of a transmitter and receiver, and the necessary hanging hook, and near the bell indicator an apparatus of similar appearance, or square base, with slightly different internal connections. The bell, indicator, and pushes, can be used as with only a bell system, it being easy to denote by an extra ring when one wishes to communicate with the domestics by telephone.

Langdon-Davies Motors.—The Langdon-Davies Electric Motor Company, of 101, Southwark Street, S.E., have issued an exceedingly neat catalogue of alternate current motors made by them under the Langdon-Davies and other patents. The attention of power users is called to the advantages of the motors as compared with steam and gas engines, and a list is given of the various circuits throughout the country upon which the Langdon-Davies motors are now working. Photographic illustrations show machine and pattern shops with motors in position, also a corner in the winding shop, and others show the motors doing driving work. Among the other useful matter in this little list of 32 pages we observe instructions for working the motors, a table of the periodicities of supply currents in various parts of the country, and some general electrical notes for the motor-user.

Large Electric Pumping Plants.—The pumping plant mentioned in our article last week was made by the Phœnix Dynamo Company, of Hubert Street, Leeds Road, Bradford.

Liquidation Notices.—At a meeting of the old British Insulated Wire Company, to be held on Wednesday, October 19th, at Prescot, an account of the winding up proceedings will be given by the liquidators, Messrs. D. L. Chalmers and E. Tracey.

The George Bullock Electro-Hydropathic Establishment, Limited, resolved on September 13th that as the company cannot by reason of its liabilities continue its business, it be wound up voluntarily. Mr. J. C. Langley, of 35, South John Street, Liverpool, was appointed liquidator.

Lists.—The Electrical Power Storage Company, Limited, has just brought out a revised edition of its useful catalogue of E.P.S. batteries. Instructions for erecting and working are followed by neatly illustrated descriptions of the various types of these well known cells for lighting, tram, motor-cab, and other branches of the electrical industry.

Messrs. J. C. Lyell & Co., send us a list of Svea incandescent lamps.

Partnership Notice.—Mr. Robert W. Blackwell announces that he has, as from the 30th inst., taken into partnership Mr. Philip Dawson, who has been an associate with him for some years past in his business of electrical engineer, merchant, and contractor. The style of the firm will be "Robert W. Blackwell & Co.," and the head offices of the business, which will be carried on as heretofore, will be 39, Victoria Street, London, S.W. The new firm will take over all the liabilities of the present business and assume all the responsibilities of the same as from the 30th inst.

Technical Education.—The syllabus of the East London Technical College, People's Palace, E., for the 1898-9 session is issued. The evening classes commence next Monday. Copies may be obtained from the Director of Studies.

The evening classes at the City and Guilds Technical College, Finsbury, in mechanical and electrical engineering and other subjects for the 1898-9 session will open on Monday, October 3rd. Programmes can be obtained at the College. See our "Official Notices" this week.

The King's College electrical engineering classes will commence on October 10th, and special attention will be given to electric traction.

ELECTRIC LIGHTING NOTES.

Alloa.—At a recent meeting of the Burgh Commissioners, Messrs. Buchan & Hogarth, electricians, Edinburgh, wrote asking to be allowed to provide specifications for the lighting of Alloa by electricity. Bailie Arrol intimated that at next meeting he intended moving that a special resolution should be adopted for the electric lighting of the town, and that the Council should apply for a provisional order.

Ayr.—The electricity accounts just issued show that the income on the revenue account for the year amounts to £2,444 15s. 5d. as against £1,970 12s. last year, an increase of £474 3s. 5d. The expenditure for the year was £1,966 6s. 2d., as against £1,986 1s. last year, a decrease on this year's working of £19 14s. 10d. The credit balance on the actual revenue account amounts to £478 9s. 3d., and this is carried to the net revenue account to meet interest and sinking fund. It falls short of this by £1,155 6s. 11d., which deficiency has been charged against the general police rate. The sinking fund now amounts to £1,154 0s. 9d. The Lighting Committee is ascertaining what course Edinburgh is adopting regarding the Zipernowski patents before resolving upon its line of action in regard to Mr. Martin Rucker's claim. The mains are to be extended down several thoroughfares upon Mr. Fuller's advice. Mr. Fuller has complained that local wiring firms have connected consumers to the street mains without his knowledge, and without putting in a meter. If this happens again the Council will prosecute.

Backbarrow.—The Brush Electric Lighting Company, which, says the *Whitehaven News*, recently purchased houses and land, together with extensive water rights, at Backbarrow, has not yet commenced active operations there. Parliamentary powers were obtained some time ago to lay mains from a central installation at Backbarrow, over several miles of road, extending as far as Grange and Carnforth on the one hand, and to Ulverston on the other. The company intends to convert the energy of the Backbarrow waterfalls (where the whole volume of the river Leven has an abrupt drop of 16 feet) into power for driving huge dynamos, which are to be supplemented by smaller ones, driven by turbine wheels, supplied from a point higher up the river, and these dynamos are then to charge a series of accumulators, which in turn will supply electricity, not only to the immediate neighbourhood, but also to the surrounding towns and villages embraced in the area covered by the Parliamentary powers already obtained. The company has invested over £30,000 in purchases of property here, and the paper mentioned says that it is clear they are in earnest about the undertaking.

Belfast.—The Lord-Lieutenant of Ireland and Countess Cadogan will visit Belfast on October 18th for the purpose of opening the new electric light station at Albert Bridge.

Bermondsey.—Mr. Cox, chairman of the Electric Lighting Committee, submitted to the Vestry on Monday an important report dealing with the electric lighting Bill to confirm the provision order granted to the Vestry by the Board of Trade. The committee pointed out that the Bill had been read three times in the Lower House, and once in the Lords, and referred to the Examiners. The Bill came before the Examiners on July 27th, when the necessary proofs were submitted, proving compliance with the Standing Orders. The limit of time for the deposit of petitions against the Bill expired on August 1st, upon which date a petition against was deposited by the London Electric Supply Corporation. There being a Sessional Order of the House of Lords that no Provisional Order Confirmation Bill brought from the House of Commons shall be read a second time after June 28th, it was impossible that the Bill could be read a second time. The Board of Trade made every effort to get the Chairman of Committees (Lord Morley) to move that the order be suspended, but without success. Mr. A. Lafone and the vestry clerk also waited upon Lord Morley and fully explained the position, and that the reason of the Bill being so late was due to the fact that as the Chairman of the Committee of the Commons, to which the Bill was referred, had voted against the second reading of the Bill, the latter was placed at the bottom of the list, so that the Committee might finish other Bills previously referred to them. Lord Morley stated that he quite appreciated the position; but as the Bill was opposed, it was impossible for him to do as suggested. It was therefore not possible that the Bill could be advanced any further steps. In order that no chance might be lost, it was suggested to Lord Morley whether he could not see his way to move that the Bill should be allowed to proceed next Session at the stage it left, as in the case of the General Power Distributing Company Bill; but Lord Morley said that it was impossible, and had only been done in that case because the Bill had been referred to a Joint Committee of both Houses. As a result, it was necessary for the Vestry to apply afresh to the Board of Trade for a provisional order, and the committee made a recommendation to that effect. This proposal was unanimously adopted, as was also a resolution convening a special meeting to deal with the question in compliance with the Electric Lighting Acts. On the recommendation of the same committee the Vestry resolved to inform the London Electric Supply Corporation that they disapproved of certain works proposed to be carried out by the company in Bermondsey New Road, Star Corner, Grange Road, Spa Road, and Jamaica Road, in so far as they related to the laying of low tension mains in those streets, and to the laying of mains on both sides of the streets specified. It was also decided to inform the company of the Vestry's intention to again apply for electric lighting powers.

Bradford.—The following figures regarding the municipal electrical undertaking, as stated by the Mayor, are more detailed than the few notes we were able to give last week. The Mayor, addressing the Council on the accounts of both the gas and electricity departments for the half-year ended June 30th, first reviewed the gas department. Turning to the electricity department, he said that a heavy expenditure had been incurred, and the proceeds were possibly not quite so large as was at one time anticipated. The total income for the half-year ended June 30th last was £9,565 14s. 7d., as compared with a sum in the corresponding period of the previous year of £8,726 12s. 3d., or an increased income of £839 2s. 4d. The total expenditure for the half-year, which included interest and sinking fund, was £7,907 4s. 5d., as against £7,061 2s. 1d. for the corresponding period. The profit for the half-year was therefore £1,658 10s. 2d., against £1,665 10s. 2d., being a very slight decrease on the similar period of last year. The number of consumers at present was 720, against 521, or an increase on the corresponding half-year of 38 per cent. The total units consumed was 480,294, against 443,288, or an increase of 8⅓ per cent., irrespective of current supplied for public arc lamps, upon which there was no return. The total profits from the opening of the electricity works in September, 1889, to June 30th, 1898, after paying interest and sinking fund, amounted to £18,391 10s. 8d., and the total amount written off for depreciation had been £7,307 15s. 6d., leaving the sum of £11,083 15s. 2d. to be appropriated as the Council directed. The trade profit—the profit before charging interest and sinking fund—was £3 4s. 9½d. per cent. for the half-year on the capital outlay of £168,506. The net profit—after charging interest and sinking fund—showed 18s. 7d. per cent. for the half-year. Taking the June and December half-years together, the trade profit was £11,784 2s. 3d., representing £7 16s. 7d. per cent. per annum on capital outlay. Of course it should be taken into consideration that the consumers had been receiving their incandescent lamps free, which practically amounted to a reduction of the price of the current. If the desires of some members of the committee had prevailed it was certain that instead of even a small profit of 18s. 7d. per cent. the balance-sheet would positively have shown a loss. The Corporation could scarcely expect to go on spending money at the rate they had been doing and to receive an immediate return, and altogether he thought that if the Council took all the circumstances into consideration they would regard the statement as fairly satisfactory.

Bristol.—Mr. George Pearson, the chairman of the Bristol Electrical Lighting Committee, is not one whit optimistic, but in a recent interview he states that the progress of electric lighting in Bristol has much exceeded anticipations. "The success," he remarks, "is best seen by quoting the cost of manufacture and the revenue for the years the station has been in existence. In the first year we spent £2,184 for manufacture, that was for five months' working, and the revenue for that period amounted to £1,594. The next year we spent £5,849 and the revenue was £6,454, thus showing that the revenue overtook the cost of manufacture in less than two years. In 1895 the cost of production was £5,825 and the revenue amounted to £9,844. At that period the suggestion for a contribution from the rates towards electric lighting disappeared altogether, whilst the most sanguine supporter of the scheme never anticipated to escape from such contribution during the first three years of the working. For the year 1896 the cost of manufacture was £7,303 and the revenue had grown to £14,863." "We then," said Mr. Pearson, "had to take an odd three months as we began at that time to make up our accounts to March 30th instead of December, the object being to bring the accounts to the same date as the other accounts. In that period of three months we spent £1,806 in manufacture, and received in revenue £5,496. In the year ended March, 1898, we spent £9,453 in manufacture, and the revenue amounted to £20,201." With such a revenue, the Committee naturally began to think of extending the lighting, and questioned as to this, Mr. Pearson's reply was: "Previous to March, 1898, we proposed to increase the public lighting, and the Council gave its sanction to increase the public lamps from 100 to 300, and the Electrical Committee undertook to reduce the price from 4½d. per unit, which amounted to about £32 per lamp, to a fixed sum of £23 per lamp, estimating, at the same time, to make a profit out of this sum. The increase in the revenue has since been so satisfactory that the Committee felt they may reasonably reduce the price to the private consumer by 1d. We made an estimate of the probable revenue to March, 1899, assuming we continued to charge 6d. per unit, and we considered that the revenue which for the year ended March, 1898, stood at £20,201, would, for the year ending March, 1899, have risen to £27,760, and upon this estimate we decided to reduce the price of current from 6d. to 5d. per unit. The taking off of £9 on each lamp is equal to a reduction of £1,800, and the reduction to the private consumer means about £4,000, which, it is hoped, will be met by an increased consumption in the future. In 1893 the Electrical Committee had 7,465 lamps installed, whilst on August 12th, 1898, they had 54,714 installed, and the increase is still going on, if anything a little faster than ever. As to the capital account, it stood on March 20th, 1898, at £160,000, and the total loan sanctioned for the completion of the works amounted to £198,000. During the time that the concern did not earn a profit, they received from the city in rates, in aid of the undertaking, a little over £11,000. Since the works had been established there has been a redeeming of the principle, and up to March 25th, 1898, £16,120 has been redeemed out of the profits of the undertaking. By the end of the present month it is hoped to pay a further sum of £3,720, so that when that is done, £20,000 will have been repaid out of the borrowed capital." Mr. Pearson acknowledges the advantage they get over a private company in such a concern, as, instead of paying 5 per cent. or 6 per cent. on borrowed money, they don't pay more than 3½ per cent., and the percentage is decreasing from 3½ per cent to 2¾ per cent. He is quite hopeful that in a few years' time the private lighting of Bristol will be electrical, as he believes electricity at 4d. per unit and gas at 2s. 2d., means that electricity, economically used, is cheaper than gas.

The Electrical Committee will join with the other municipal authorities and companies in resisting Mr. Martin Rucker's claims *re* the Zipernowski patents.

Brentford.—The District Council on Wednesday resolved to apply for a provisional order to light the town by electricity. They have resolved to establish a dust destructor, and the heat will be utilised in connection with the lighting.

Brighton.—Brighton proposes to spend a further sum of £56,300 on electric lighting during the next two years, and Mr. Ducatt held a Local Government Board inquiry into the matter at the Brighton Royal Pavilion on Wednesday last week, when it was explained that the amount proposed to be borrowed was larger than had been borrowed before, and that arose from the fact that the Local Government Board had asked that these loans should be applied for before the expenditure was incurred. The present debt of the Corporation on the electric lighting account is £206,076 7s. 9d., while an additional £11,426 had been sanctioned but not yet taken up. The electrical engineer (Mr. Wright) explained that about 450 new customers for each year were expected during the next two years at any rate, and sufficient capital had been provided to supply their wants. No one opposed the application.

Burton-on-Trent.—The Council will join with others in resisting Mr. Martin Rucker's claims *re* Zipernowski patents.

Canterbury.—Mr. Stephen Horsley, M.I.C.E., who represented the Canterbury Town Council at a recent gathering of the municipal engineers at Edinburgh, has just read a paper to his Council on "The Electric Lighting of Edinburgh." Mr. Horsley described the chief points in the system, and the success with which it had been operated. He advises Canterbury to see whether free wiring cannot be introduced. The Council has thanked Mr. Horsley for his trouble in the matter.

Cardiff.—The Local Government Board has consented to £28,125 being borrowed by the Corporation for electric lighting purposes, and £500 for extension of electric light in Newport Road. The statement of accounts just submitted by the borough treasurer, also details how there is included in the overdraft of £206,581 expended on capital account, which will be included in the next issue of Corporation stock; £34,231 on electric lighting account, render their account of this year. The Corporation have, it is understood, obtained large borrowing powers, and these include, in respect of electric tramways, £261,510.

Carlisle.—At Friday's meeting of the Council, Mr. Scott said that the electricity works were making good progress, half the cable had been laid, 11 out of the 25 standards required had been erected, and all the arc lamps delivered. The engines and dynamos were ready for erection, the only delay had been in supplying the boilers; but Prof. Kennedy was threatening to put in force the time clause of the agreement, and he hoped the light would be ready towards the end of November. One thing he wished made public; the Committee did not intend to wire private houses, so as not to interfere in any way with the tradesmen in the city.

Castleford.—This growing industrial centre, 10 miles from Leeds, has decided to go in for the electric light. The Urban Council has ordered the clerk to apply for a provisional order.

Chelsea.—In his annual report (1897-8) to the Vestry, Mr. T. W. E. Higgens, the surveyor, says that the number of houses in Chelsea lighted by electricity for the last three years was as follows:—

	1895-6	1896-7	1897-8
Chelsea Electricity Supply Company	777	1,032	1,243
London Electric Supply Corporation	(?)	(?)	(?)

The pressure records of the Chelsea Electric Supply Company have been examined from time to time, and their high standard of efficiency has been fairly well maintained. The question of lighting Kensal Town by electricity was under consideration during the year, but the Vestry seemed to consider that the initial expense was too great. At the end of the financial year, Mr. Higgens reported upon the advisability of obtaining motor dust vans, but the matter is still under consideration.

Chislehurst.—At a meeting of the Parish Council some days ago, a letter was read from Messrs. Edmundson, acknowledging the letter consenting to the company laying down the proposed mains for electric lighting, and accepting the conditions to make up all highways and pathways interfered with to the satisfaction of the highways surveyor, and also to keep the same in repair six months after the work had been executed.

Cleckheaton.—The Electric Power Distribution Company has asked the District Council if it will agree to its proposed application for electric lighting powers.

Clitheroe, Lancs.—At the present time electric light is used at only one place in the borough—Cunningham's Cycle Works. A new mill, which is being re-started after lying idle for many years, is, however, having a special plant put in on a fairly large scale.

Colwyn Bay and Colwyn.—The surveyor is to bring before the Works Committee a scheme for lighting the main road by electricity.

The Public Works Loan Board have advised the Colwyn Bay District Council, agreeing to make an advance of £1,564 for electric lighting purposes. The clerk of the Council has been directed to proceed with the matter.

Cromer.—The Urban District Council has appointed Messrs. O'Gorman & Ocsens-Hardy engineers for the electric lighting scheme which is now in course of preparation.

Cupar.—The committee which has been going into the matter cannot recommend the purchase of the gasworks at the price suggested by the company. The committee received an offer from Edmundson's Electricity Corporation to put down an installation for the Town Council, and to light the streets and the Town Hall at a cost not exceeding that at present paid for gas lighting. The committee laid the terms of the proposal before the Council last week. From the tone of the discussion it seems that the electric light question will be more fully discussed shortly.

Dufftown.—The installation of electric light at Mortlach Distillery has now been completed. The dynamo is driven by a Pelton wheel by water taken in metal pipes from Nether Cluny dam. There is 200 feet of head, and consequently an enormous pressure, and this, applied to the wheel, produces about 20 H.P. The dynamo is by Messrs. Crompton & Co. There is a set of 53 cells to give four days' supply for 200 incandescent lamps of 16 C.P. each. At the switchboard current is controlled for lighting the distillery, Dullan Brae, and the brewer's house. Messrs. P. C. Middleton & Co. carried out the work.

East London (South Africa).—The Harbour Board have decided to accept an offer of the Town Council to erect electric lighting plant for the harbour works, the Council having quoted the charge for the light in the first instance at 9d. per unit. The Board's plant will cost about £2,800.

Edinburgh.—In the first 15 weeks of 1895-96 equal to 10,450 8-candle-power lamps were joined on, and 16,739 were applied for. In the corresponding weeks of 1896 97 4,875 were joined on and 16,712 were applied for. In 1897-98 for the first 15 weeks 8,882 8-candle-power lamps were joined on and 26,298 applied for. In the present year, says the *Scotsman*, the Committee have joined on in 15 weeks from May 15th 14,044, and had applications equal to 29,490 8-candle-power lamps. During the same period the consumption in 1895-96 was 40,640 units; in 1896-97, 92,312 units; in 1897-98, 185,021 units, and for the same period this year it had been 375,628 units—showing a steady increase from year to year for the first 15 weeks of about 100 per cent. The increase for the whole year of 1896-97 over the previous year was 86 per cent., that of 1897-98 over 1896-97 was 88 per cent., and so far this year promised equally well, and it was estimated that there would be an output of 75 per cent. over last year. Taking it at this there would be 3,463,558 units sold for private lighting at an average price of 3·15d., giving an income from that source of £45,459 3s. 10d. The public lighting being £9,940 and £50 from other sources, they had a gross revenue of £55,449 3s. 10d. The total expenditure was estimated at £43,949 3s. 10d., including £19,190 for interest and sinking fund, thus leaving a surplus of £11 500. Of this sum the Committee recommended the Council to put £7,000 to the reserve fund, raising it at the end of the financial year to £15,000. The balance of £4,500 went in relief of the rates.

The Town Council has decided to fix the minimum charge for private consumption of electrical energy at the rate of £1 per annum.

Treasurer M'Crae last week put before the Council reports by various Committees as to the estimated expenditure for the current year. The increase in revenue from electric lighting is put at £18,795. The expenditure on electric light is estimated for the year at £130,500, an increase of £83,600.

Eton.—A short time ago the Eton Urban District Council appointed a committee to report upon the mode of lighting the public streets with electricity. The report was submitted on Thursday evening last week, and was to the effect that the cost of electric light, in accordance with a scheme set out in detail, would be £180 per annum, as against £110 now paid for gas, and also that the Windsor Electric Installation Company would require a guarantee from the Council to use the light for a certain number of years in return for expenses incurred in erecting brackets, standards, lamps, &c. The report was criticised by the members, and in the end it fell through.

Farnham.—The committee appointed to consider electric lighting for the town has decided to obtain expert advice.

Forfar.—Messrs. John Lowson, jun. & Co., Victoria Linen Works, Forfar, have decided to light the whole of their extensive factory with electricity. The work will be commenced in the course of a few weeks. Messrs. Laird & Co., Canmore Linen Works, Forfar, were the first to introduce the electric light into the town, and it has worked very successfully at their works for over 12 years.

Frodingham.—The District Council will apply for powers for lighting the district "by gas or electricity."

Greenwich.—The Board of Trade has consented to the supply of electrical energy by the District Board of Works on the alternating current system within that part of the area of supply not included in the area of the London Electric Supply Corporation Order of 1889.

Hackney.—Last week the Vestry got to business in regard to electric lighting. After discussion, Mr. Robert Hammond was selected from among several names put forward, to prepare and submit, for a fee of £50, a report under the following heads:—(*a*) On a combined scheme of electric lighting and dust destructor; (*b*) for electric lighting only, without a destructor; (*c*) for the supply of electricity either by a combined scheme or otherwise, within the compulsory area only; (*d*) for the supply of electricity either by a combined scheme or otherwise, over the whole area of the parish. The report to also give an estimate of the cost of carrying out the schemes under the above heads, and also the cost of maintenance. The Vestry reserve to themselves the power to carry out the work contained in such report either with or without the assistance of the engineer submitting the same. The Moderate party on the Vestry who have opposed this matter in a ridiculous fashion from the very commencement, voted in a body against the resolution. Although the Progressive party, which is pushing the scheme forward, has a good workable majority for settling the various questions that will necessarily arise, there is every indication that there will be a good deal of trouble in the Town Hall over the matter. This state of things will doubtless continue until the installation is beginning to show signs of success, and then we shall see what we shall see—whether the opposition is pig-headed or whether the opponents are open to conviction.

Hanley.—A Local Government Board inquiry was held on Wednesday last week, regarding the Council's application for sanction to borrow £4,000 for purposes of electric lighting. The town clerk said that there were 363 private customers at present, and they were rapidly increasing. The present application was made with a view of providing additional feeders to the central area of that town, known as the compulsory area. It was to relieve the present pressure on the mains caused by the increased consumption. Mr. Cowell, one of the electrical engineers, produced diagrams showing the number of private lamps and the increase monthly during the past year. The private lamps were equal to 25,750 lamps of 8-C.P. They wanted a new high tension feeder. Mr. Lobley said, while having the ground open they wanted to take advantage of that to lay down low pressure distributing mains. The application was to meet requirements for another 12 months.

The Council will join with other interested parties in resisting Mr. Martin Rucker's claims.

Hull.—Last week the Electric Lighting Committee considered tenders for a new engine (750 horse-power), two Lancashire boilers and dynamos for the new station in Sculcoates Lane, and in connection with East Hull extension. It was decided to accept those of certain firms, subject to inquiries being made by the chairman, deputy-chairman, and electrical engineer.

Hythe.—Mr. Risch, of Folkestone, has offered to draw up a scheme for supplying electric light to the town, free of charge, on condition that, if the scheme was adopted, he was appointed electrical engineer to see the work carried out, and afterwards remained in charge of the works. The whole matter of electric lighting was referred to a committee, consisting of the whole Council.

Johannesburg.—The lighting works, for the extension of which new bonds have just been issued, were taken over by the Town Council in April, 1895, since when fair progress has been made. The amount of electricity generated monthly has grown from 20,000 to 76,000 units, and the gas plant has also been greatly extended. The Council has at present 600 electric current consumers and 388 gas consumers, whereas when the undertaking changed hands, the consumers only numbered 96 electric and 287 gas. The public lamps have increased from 104 to 435 gas lamps, from 19 to 684 electric incandescent lamps, and 47 arc lamps have been added. The private electric lamps in use and connected with the Council's mains are equal to 30,000 lamps of 8 candle-power each, as against 5,000 when taken over.

Kingswood.—The Local Government Board has informed the Council as to the form of application for sanction to borrow money for purchasing the electric lighting plant.

Kirkcaldy.—The Town Council met the other day to consider the proposal of the Corporation to take up electric lighting and tramway schemes. Letters were read from the local company offering to take up the schemes, and allow the Council to take them over at the end of 35 years at a cost fixed by arbitration. The Edmundson Electric Light Company offered to introduce the electric lighting to the burgh, allowing the town to purchase the scheme at the end of 10 years at 15 per cent. on the cost. It was agreed that the Town Council should apply for a provisional order to introduce the electric light themselves, while a subsequent motion was made to apply for an Act of Parliament to introduce electric tramways, the idea being that the town, having got the sanction of these schemes, could then hand them over to any company offering the best terms. A large Committee was appointed to prosecute the procuring of these orders.

Lambeth.—The Vestry last week had a discussion regarding the reply of the Local Government Board to the effect that it has no power to intervene in the matter of the desired inquiry into the circumstances of the transfer of the provisional order. The Vestry eventually resolved to again appeal to the Local Government Board for a public inquiry.

(*Continued on page 457.*)

THE NEW ALTERNATORS FOR THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

The two-phase machines which have been built for the Metropolitan Electric Supply Company by the Westinghouse Electric and Manufacturing Company and the Westinghouse Machine Company, of Pittsburg, Pa., have been recently described by the *American Electrician*, from which the following details and illustrations are taken :—

The order was for 7,500 H.P. (in three units). These units, though large for British practice, are but half the size of the Westinghouse generator units at Niagara Falls (5,000 H.P.), but as they present a number of unique features of design and construction which have been developed by the Westinghouse Companies in their latest practice, a description of these alternators will be of special interest. The engines in particular are worthy of close study.

These three units are intended to supply primarily the arc and incandescent lighting service in London, but a portion of the power will be used for operating rotary transformers, which will, in secondary three-wire, direct-current distribution circuits, supply motors and storage batteries.

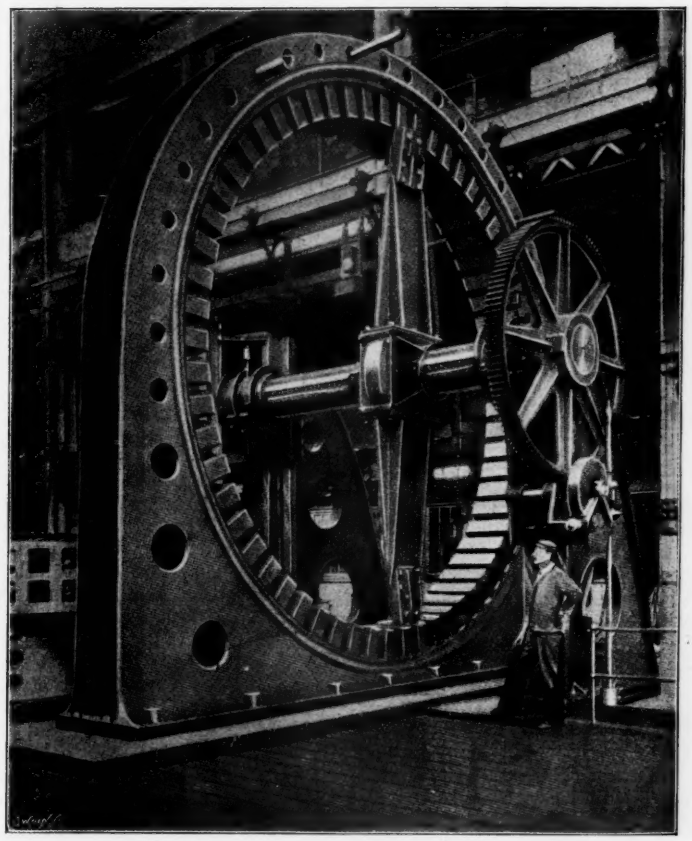


Fig. 1.—Boring Large Alternator Field.

The engines are the largest machines yet turned out at East Pittsburg, where the new shops of the Westinghouse Machine Company are located. The illustration on p. 456 shows a general view of the engine to excellent advantage, and by reference to the line drawing still further information can be had concerning this interesting prime mover. The engine, when operating non-condensing, is capable of developing the full rated power of the generator it is to drive, namely, 2,500 H.P. at 133 revolutions per minute, the steam pressure being 100 lbs. If run at 120 revolutions per minute with 140 lbs. steam pressure, the engine can be loaded and will successfully carry 3,500 H.P. All of the parts are strong enough to withstand a steam pressure of 200 lbs. to the square inch. The bed plates of these machines are of heavy box castings, intended to fit down over concrete foundations. The high and low pressure cylinders are 36 and 55 inches in diameter respectively. The stroke is 36 inches. The cylinders are made of close grained cast-iron, and, as the engine is of the vertical type, the danger of cutting the cylinder castings is practically negligible. The steam is distributed to the high pressure cylinder by a double ported piston valve, and two single ported piston valves perform the same office for the low pressure cylinder. The cylinders, covers, pistons, &c., are provided with improved means to render their removal easy. Appropriate drains connected to the cylinders and steam chests and fitted with automatic water relief valves keep these important organs of the engines free from condensation. The drain valves are conveniently operated from the working platform by appropriate levers.

The crankshafts are of forged steel, 14 inches in diameter at the bearings and 20 inches at the armature hub. They are hollow throughout their entire length. The crankshaft extends, as will be noted in the pictures, so that the armature, which is the revolving element of the generator, may be mounted directly on the engine shaft and serve as a fly-wheel.

The engines are fitted with permanent indicator rigs, which are accessible from the main platform, together with an elaborate system of lubrication, a system of cooling the bearings, and provision for varying the speed while running. All of these assist in enabling the engine to run for long periods without stopping. The main bearings of the engine are cooled by water, which is circulated about them. They are of the quarter-box type, and can be moved in any direction by means of suitable wedges, which can be adjusted from without. The bearing shells are of cast-steel or bronze, as the conditions may require, and are lined with the best babbitt metal. They are 14 inches in diameter and 28 inches long. Provision is made to allow the covers to be raised to facilitate inspection.

The lubricators are sight feed. The oil is carried through brass tubes from the sight feed oilers and manifolds on the cylinders. These are connected to a reservoir on top of the cylinders, which is supplied by a force pump, which takes the oil from filters.

The engine is controlled by an open single weight inertia governor, which actuates the high pressure valve. The low pressure valves are operated by fixed eccentrics. The

F

governor is keyed to the main shaft, and is capable of 10 per cent. adjustment while the engines are running. This is an important feature, for it enables the speeds of the machines to be varied to facilitate parallel operation. The maximum variation of governing at any speed within the rated limits is 1 per cent. The throttle is operated by a hand wheel, which is situated on the working platform.

The generators were built by the Westinghouse Electric and Manufacturing Company. They have a nominal output of 2,500 H.P., and are capable of delivering two-phase currents at a pressure of 500 volts. The field, or stationary element, is provided with 62 inwardly projecting pole pieces. These pole pieces are built up of laminated steel sheets and are cast into the frame. An excellent view of the field frame is shown in fig. 1, in which it is in the process of being bored. This massive member, with its 62 pole pieces, cast, as they are, at accurately spaced intervals into such a heavy mass of metal, represents no mean specimen of the founder's art. The immense boring bar and the correspondingly large devices for centering the field frame about it are an illustration of the magnitude of the generators and the facilities which were necessary for performing and carrying out such a contract as this one. An interesting view of the completed field is shown in fig. 2. In this picture, as will be noted, it is lying on its side and is complete with its field bobbins in place. The dividing line in this casting is vertical, and enables the two halves of the field frame to be withdrawn, thus exposing the armature for inspection or repair.

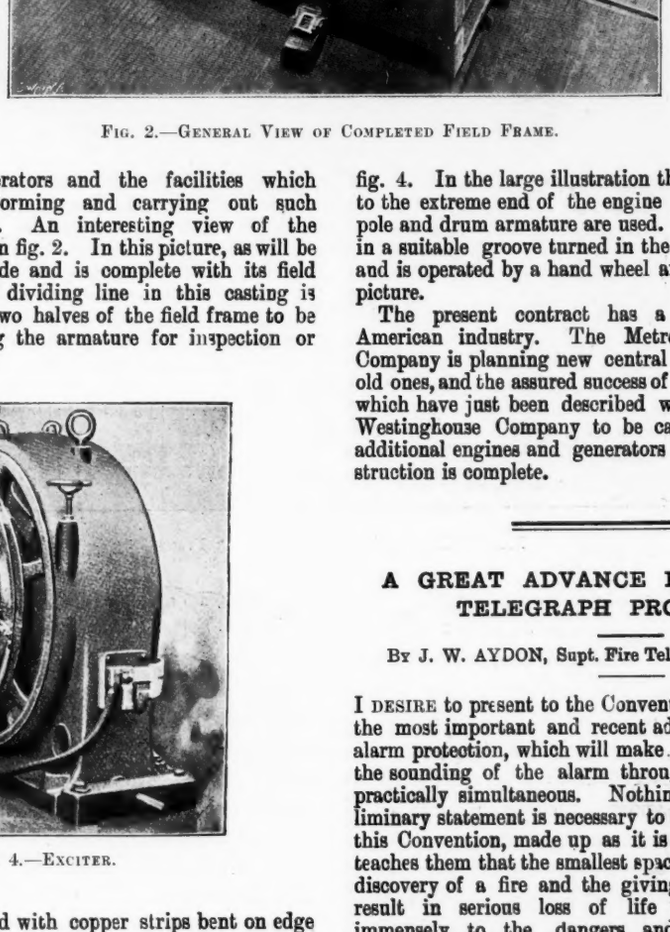


Fig. 2.—General View of Completed Field Frame.

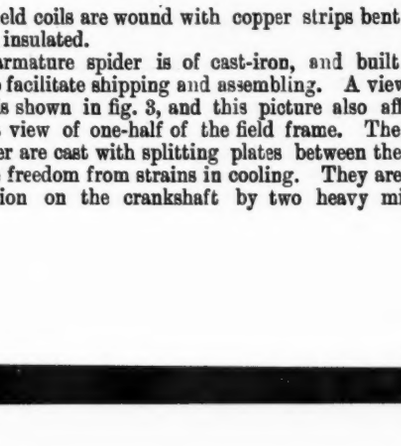


Fig. 4.—Exciter.

The field coils are wound with copper strips bent on edge and well insulated.

The armature spider is of cast-iron, and built in two halves to facilitate shipping and assembling. A view of this casting is shown in fig. 3, and this picture also affords an excellent view of one-half of the field frame. The arms of the spider are cast with splitting plates between them, so as to insure freedom from strains in cooling. They are secured in position on the crankshaft by two heavy mild steel rings, which are shrunk around the bosses at the base of the arms.

On the periphery of this casting are mounted steel punchings, which are suitably notched to receive the armature conductors. These are large copper bars of rectangular section, which are heavily insulated and imbedded in the slots. The laminæ on the armature are assembled so as to allow for numerous ventilating ducts, thus enabling the ample passage of air through the core, and keeping the temperature of the armature very low. The armature is wound with a distributed closed circuit winding, and the four collector leads draw their current from 124 equidistant points on the winding. The commercial efficiency of each generator is 95 per cent. at full load and 91 per cent. at half load.

The excitation of these gigantic machines is particularly interesting, as the exciters, which are, of course, machines of small capacity, are connected directly to the engine shaft, the speed of which, it will be remembered, is only 133 revolutions. The direct current dynamos which supply the exciting current at this extremely low speed are shown in fig. 4. In the large illustration they will be seen connected to the extreme end of the engine shaft. An internal radial pole and drum armature are used. The brush ring is centred in a suitable groove turned in the yoke of the field frame, and is operated by a hand wheel and worm, as shown in the picture.

The present contract has a further significance for American industry. The Metropolitan Electric Supply Company is planning new central stations and re-equipping old ones, and the assured success of the engines and generators which have just been described will undoubtedly cause the Westinghouse Company to be called upon to supply many additional engines and generators before the work of reconstruction is complete.

A GREAT ADVANCE IN FIRE ALARM TELEGRAPH PROTECTION.*

By J. W. AYDON, Supt. Fire Telegraph, Wilmington, Del.

I desire to present to the Convention a brief description of the most important and recent advance in methods of fire alarm protection, which will make the outbreak of a fire and the sounding of the alarm through the municipal system practically simultaneous. Nothing further than this preliminary statement is necessary to command the attention of this Convention, made up as it is of men whose experience teaches them that the smallest space of time lost between the discovery of a fire and the giving of an alarm may often result in serious loss of life and property, and add immensely to the dangers and difficulties which fire departments have to contend with in the performance of their duty.

I refer particularly to a combination with the well-known auxiliary fire alarm system of a so-called "multiphase" cable, which combination makes the auxiliary system automatic as well as manual.

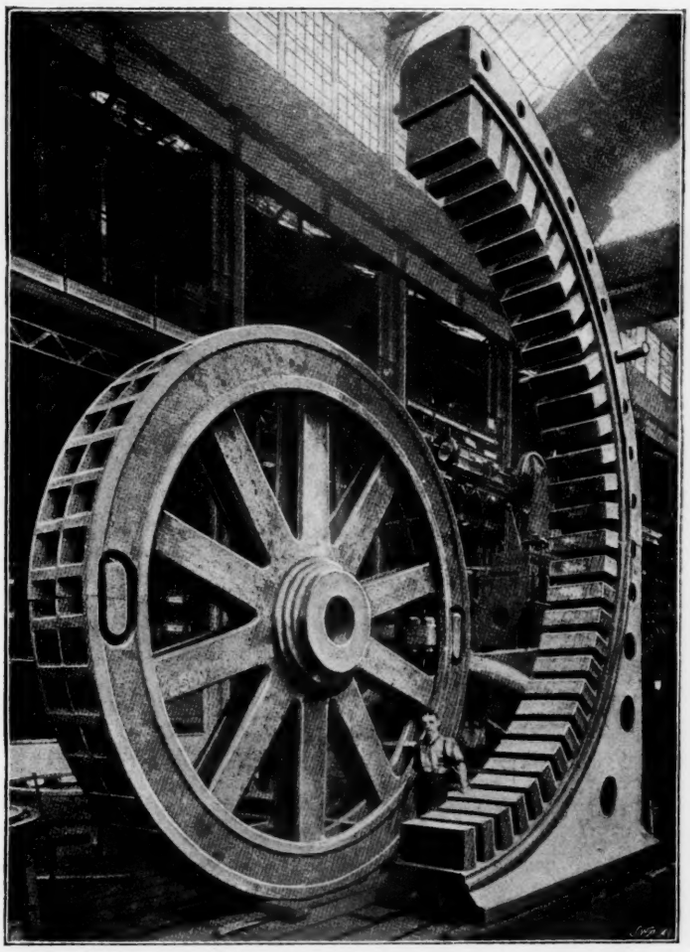
* Paper read at Municipal Electricians' Convention, Elmira, N.Y.

The auxiliary system proper was an immense step forward in this vital matter of minimising the time between the discovery of a fire and the giving of an alarm, and its record throughout the country for the past six years has been a most excellent one. During this time it has been in quite extensive use in many of the large cities of the United States, and in those places has been a considerable factor in reducing the fire losses, and has been a material aid to the fire departments.

In the city of Wilmington it has rendered exceptional service to property holders and to the department, and has been the means of preventing several serious fires by enabling the fire department to reach the scene of the fire some minutes sooner than would have been the case otherwise.

The auxiliary system, in effect, brought the nearest public fire alarm box into the interiors of buildings, and placed it at any desired number of points, by providing a series of small auxiliary boxes, from any one of which the street box could be instantly operated by the pulling down of a lever contained in each auxiliary box. But the system, being purely manual, was not effective when the protected premises were vacant; and it was to cover this point that the method of rendering the auxiliary system automatic, as well as manual, was perfected.

The great value of an automatic connection with municipal fire departments has long been recognised, and for many years received the hearty co-operation and encouragement of insurance underwriters and fire department officials; and under the fostering influence of these interests it has rendered, and is rendering, most valuable service.



Metropolitan Company's New Alternators.—Fig. 3.—Field Casting and Armature Spider.

The growth of the automatic system, however, has necessarily been confined to the larger cities, for the reason that it is necessary to maintain the system in connection with its own central office, through which alarms of fire have to be transmitted to the fire department. The expense of wiring and the cost of maintaining a central office equipment is so great that the business cannot be made a commercial success, except in large cities where the volume of business is considerable.

For smaller cities, where the amount of property to be protected is not so large, but relatively equally valuable, the automatic system is not available; but the record of this system covering a period of many years has exclusively proven that a reliable automatic system, available wherever there is a fire department, would be of vast importance.

The successful operation of an automatic system in smaller places is now for the first time in the history of fire telegraphy possible. It has never been a matter of electrical mechanical difficulty to connect ordinary thermostats into an auxiliary system so that an excess of heat would automatically operate the street box, but the danger of unnecessary alarms has prohibited this.

The recent invention of the "multiphase" cable, referred to above, has been adapted for use in connection with the auxiliary system so that it becomes automatic, as well as manual, without the sacrifice of any of the peculiar features of safety from false alarms, which is the foundation of the willingness of fire departments to allow its use in connection with street boxes.

This "multiphase" cable is of peculiar contruction, as will be noted from the drawings which I have for your examination. Briefly, it consists of a copper conductor having a fusible metal covering, with insulated material over it, around which is wound a series of small copper wires, the whole being again protected by a slow-burning insulation. This cable is wired into the auxiliary system in the place of the ordinary wire heretofore used, and in connection therewith is run a single wire composed of fusible wire only, and protected with a free-burning insulation.

An automatic auxiliary equipment would, therefore, consist of the desired number of auxiliary boxes, distributed throughout a building at convenient locations, connected through the usual testing apparatus, with the nearest street fire alarm box. The interior wiring of the equipment would be of this "multiphase" cable described, and the single fusible wire mentioned, the cable wire being run parallel to each other.

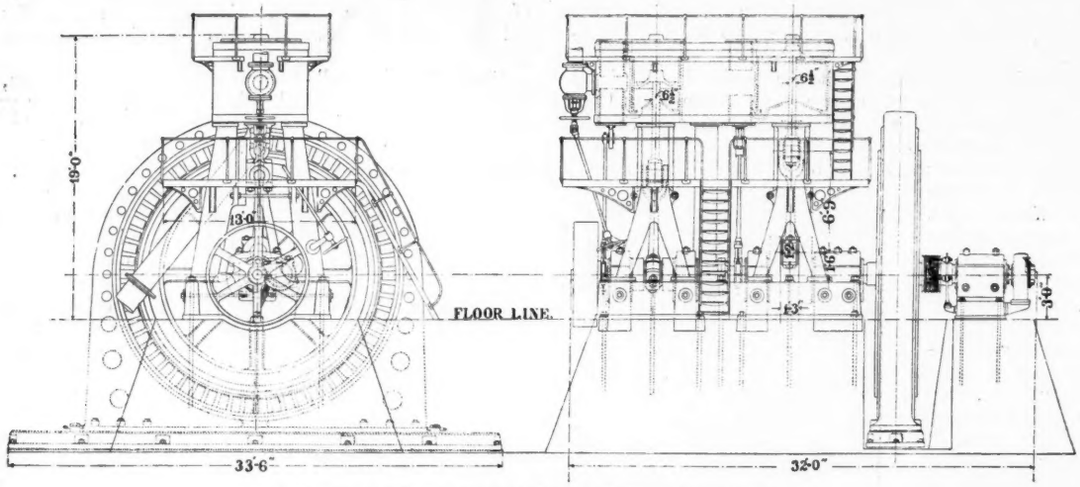
As fires do not start upon the ceilings of rooms (where the ordinary thermostats are placed), the automatic wires referred to would be run around base boards, back of benches, through closets, under staircases, &c.; in fact, so as to cover every danger point where a fire would be likely to start. These danger points can be scientifically located for each class of risk, by a reference to insurance tables giving the accumulated experience of all the insurance companies for a period of years, as well as by individual judgment in each case.

It will, therefore, be seen that such an equipment would provide a number of auxiliary stations, which, when manually operated, would instantly get the street box in motion, thereby giving the alarm to the fire department; and would also provide for the covering of all danger points in the building by the automatic cable as indicated.

There is no necessity of describing the operation of the auxiliary system proper—*i.e.*, when operated manually; so we will pass to the working of the "multiphase" cable when it comes in contact with actual flame.

First, however, let me call the attention of the Convention to the fact that it takes actual flame, or a temperature of 360° without flame, to cause this wire to send in an alarm, and this, therefore, prevents false alarms from an overheating of a building, which might not necessarily be dangerous.

This failure to act until the flame comes in contact with the wire or until a temperature of 360° is reached, does not imply that the wire will not give the alarm for an actual fire as quickly as a thermostatic equipment would do; on the contrary, it would doubtless, in most instances, give it quicker, for the reason that every fraction of an inch of the wiring of an auxiliary system would be an alarm-giving point, located where the fire would probably start, instead of being away up on the ceiling, perhaps many feet away from the fire.

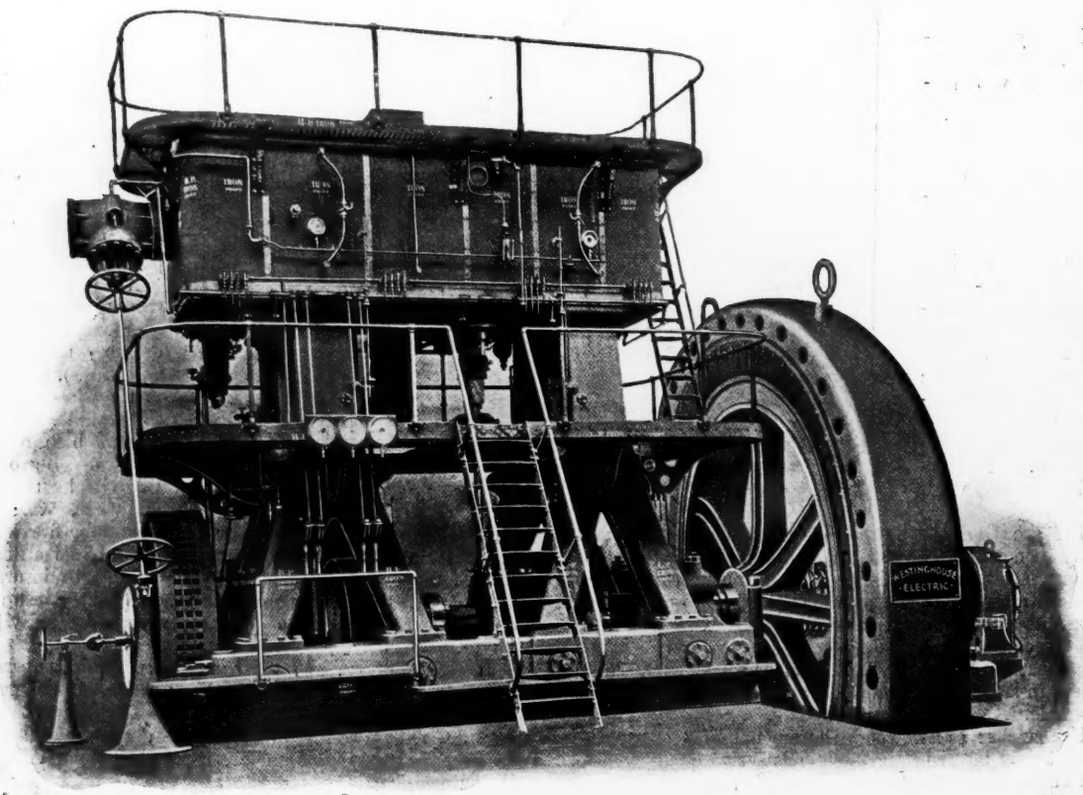


Drawings of Metropolitan Company's New Alternators.

Returning now to the operation of the wiring of an auxiliary system equipped with the "multiphase" cable, under the influence of flame, or 360° of heat; the single fusible wire melts open, and the fusible metal covering of the inner wire in the cable melts, and forcing its way through the insulation, makes a solid soldered connection with the series of copper wires described.

This action of the wire produces a condition in the auxiliary system exactly the same as that brought about by the manual pulling of one of the auxiliary boxes, and the alarm through the street box is the immediate result.

This combined system, like the auxiliary system proper, is at all times under automatic test, so that any line or battery disarrangement will be instantly made known.



One of the Metropolitan Company's New 2,500 H.P. Steam Alternators.

The fact that this cable required flame, or a temperature of 360° to operate it, insures it against any liability to false alarms, for conditions producing a temperature at which thermostats act unnecessarily, produce no effect upon it.

This system combines all of the advantages of an automatic system with all those of the auxiliary system, without any of the disadvantages of the former. It is available wherever there is a street box, in a large city or small town.

To sum up briefly, the automatic-auxiliary system enables the instant and manual sending of an alarm of fire, and also provides that every fractional part of an inch of its wiring shall be an untiring watchman ready at all times to instantly give the alarm when dread fire makes its appearance.

I think the Convention will agree with me that making the fire send its own alarm is a notable advance in the business to which we are devoting our lives.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 452.)

Lincoln.—With the installation of the electric light at Lincoln, it was only to be expected that several new places of business would be opened for the supply of electric materials, &c. The National Free Wiring found spacious premises at the corner of Guildhall Street and Mint Street, and have been doing a brisk trade in fitting up private houses, preparatory to the current being supplied by the Corporation in October. Messrs. Kinleyside & Co., electrical contractors, were also early on the scene. Mr. Howard, of Silver Street, has also added an electrical branch to his photographic business, and Wallis Bros., of 150, High Street, are also doing electrical work.

Llandudno.—Mr. W. H. Preece informed the Electric Lighting Committee last week that the electric lighting apparatus and refuse destructor will be ready in a month's time.

Longton.—The Town Council last week passed a special resolution applying for a provisional order, and relegated the carrying out of the scheme to the Gas Committee.

Macroom.—Messrs. Thierman, of Manchester, have secured the contract for the electric lighting of the town of Macroom, County Cork, which has a population of about 3,500.

Maidenhead.—The Town Council has appointed Messrs. Burstall & Monkhouse to act as consulting engineers in connection with the proposed electric lighting installation.

Maidstone.—On Wednesday the Town Council decided to advertise for competitive designs and schemes for combined electricity supply works and refuse destructor, and to offer a premium of £100 for the best scheme.

Manchester.—Mr. C. H. Wordingham, the Manchester city electrical engineer, has issued a series of new regulations, 61 in number, for the use of the electrical department of the Manchester Corporation, in connection with installations which are to be supplied from their electrical mains.

Musselburgh.—The Town Council has conferred with a London syndicate which proposes to introduce electric lighting and trams. A Committee has since been appointed to make full investigations.

Neath.—At the last meeting of the Rural District Council, notice of motion stood in the name of Mr. William Howell: "That the Council take the necessary steps to obtain powers to provide the Skewen district in due course with electric light, and that a committee be appointed with powers to deal with the question," but Mr. Howell gave notice of motion to embrace in the scheme the whole of the district within the jurisdiction of the board.

Newington.—At last week's meeting of the Vestry, the Electric Lighting Committee reported that during the recess, under the powers vested in them, they had accepted the tender of the British Insulated Wire Company for the insulated electric mains, conduits, junctions, boxes, &c., at £9,081 19s. 6d.; the tender of the General Electric Company, Limited, at £1,457, for the main switchboard and instruments; and the tender of Messrs. Pritchetts and Gold of £900, for the battery of accumulators and accessories, which now covered the whole of the work to be let under contract. The following was a summary of the contracts, namely:—The station, £12,928; supply and fixing of engines, generators and public lighting plant, £8,975; supply and erection of boilers, £9,348; electric mains, conduits, &c., £9,082; main switchboard and instruments, £1,457; accumulators and accessories, £900. To this had to be added 7½ per cent. for engineers' commission, clerk of works' salary, and contingencies, £3,002, which brought the total up to £45,692. In view, therefore, of the necessity of further extension of mains down Westmoreland Road and East Street, the committee advised that the loan be increased to £50,000, and the money be raised under the instalment system, repayable within 42 years, the Council being asked to accept the deferred system of payment of the capital for five years. The committee therefore recommended that the first resolution passed, making application for a £40,000 L.C.C. loan, be rescinded, and that the following resolution be substituted in lieu thereof:—"That application be made to the London County Council for a loan of £50,000 to enable the Vestry to carry out the provisions of the Newington Electric Lighting Confirmation Act of 1897, such loan to be taken up in instalments of £10,000 as the work proceeds, and repaid within a period of 42 years, and that the Council be asked to defer the repayment of the principal for a period of five years, under Clause 11 of Section 14 of their Money Act of 1898." Mr. Edwards moved the adoption of the report. He said that the Vestry had decided to enlarge the generating station, proposed in Mr. Manville's report, and further to obtain a mechanical stoker. These would entail an additional cost of £10,000 beyond that estimated in Mr. Manville's report. There was a good deal of time wasted in petty personalities, after which the motion was carried by a large majority.

Oldham.—Major Cardew has made a Board of Trade inquiry into the causes of the explosion which occurred at Bottom-o'-th'-Moor on August 10th. He has sent a copy of his report to the Electric Lighting Committee. After explaining the cause, which has already been reported, he mentioned that the large culvert has since the explosion been replaced by iron pipes containing insulated cables in place of bare conductors. There were, however, long lengths of similar culverts still in use in other parts of the town. None of these culverts were at present ventilated, and any of them might become receptacles of explosive gas. The inspector discussed the matter with the officials, and it was agreed that the following alterations should be carried out for avoiding risk of explosion:—(*a*) All service pipes to arc lamps to be replaced by armoured cables laid solid without pipes; (*b*) all pipes communicating with culverts or steel boxes to be plugged at the ends; (*c*) long lengths of culvert to be broken up by interposing at intervals cables laid on some solid system instead of the existing bare mains; (*d*) all culverts to be ventilated as well as can be arranged; (*e*) frequent inspections to be carried out, and corners of street boxes to be lifted for such time as will allow a change of air. The inspector did not think that anything further could be done. The ventilation of the culvert, he remarked, appeared to be very difficult to carry out in a satisfactory manner, and frequent inspection was probably the best safeguard.—Councillor Harrop asked if it would cost a lot of money to carry out the recommendations? Mr. Newington replied that it would not. Mr. Andrew, superintendent, said the cost of relaying the cable and the repairs was about £80.

Perth.—On Thursday last week the Electric Lighting Committee of the Police Commission heard a statement by Mr. W. C. C. Hawtayne advising a municipal installation. The Committee, however, recommends the handing over of the powers to a company. Several are anxious to take the matter up. The matter is delayed pending the receipt of further information.

Plumstead.—After conferring with Prof. Henry Robinson the Vestry, while not pledging itself to the details of his report, has decided to apply for a provisional order for lighting the parish. The Works Committee will no longer be troubled with this subject, a special Electric Supply Committee having been appointed.

Poplar District.—The Poplar District Board of Works, which is really the large districts of Bow, Bromley, and Poplar combined, continues to wrangle and hesitate over the electric lighting of the districts, and not much progress seems to be made in the matter. At the Tuesday's board meeting there was a lengthy squabble as to what they should pay an electrical engineer who had been advising them. The Electric Light Committee proposed £25, but some members thought £10 was plenty. However, £25 was voted.

Rhyl.—A committee of the District Council has been considering draft schemes for the lighting of certain parts of the town electrically, and for constructing a tramway between Rhyl and Prestatyn. Messrs. A. Dickinson & Co. are to submit a detailed lighting and tramway scheme, and Councillors will visit several towns to see such undertakings in operation.

Romford.—It is stated that Messrs. Ind, Coope & Co., contemplate putting a large electric light installation into their Romford Brewery, and carrying the light to their various inns in the town.

Rothesay.—The Electric Light Committee hopes to be able to proceed with the electricity undertaking so as to have the installation completed in the early spring months.

Royston.—Mr. Edwards, an electrical engineer, asked the Council's permission to erect an electric light installation for the township. The Council has told him to, along with the clerk, inquire of the inhabitants whether electric light is wanted. If the Council then decides to light the district, it will pay Mr. Edwards's expenses.

Sandgate.—The District Council has invited Mr. Hall, solicitor of Folkestone, to explain his proposals *re* electric lighting to the General Purposes Committee.

Shoreditch.—The Vestry will ask the members of Parliament for the district to strongly oppose the Bill promoted by the General Power Distribution Company, and Bills of a similar nature. On behalf of the Lighting Committee, Mr. Kershaw reported the receipt from Mr. Russell, the chief electrical engineer, of a letter asking for the Vestry to reconsider the question of his remuneration. Mr. Howlett proposed that the matter should be referred to the Officers' Committee for consideration, and this was eventually agreed

to, although the chairman of the Lighting Committee objected to the action of that committee in not bringing forward a resolution on the subject.

Southampton.—The Electric Lighting Committee has accepted an offer of the General Electric Company to allow 25s. each for the old Aron meters in exchange for meters of the new type.

Standford-le-Hope.—Last week the members of the Parish Council were occupied with Mr. Simpson, electrician, in selecting sites for the electric light standards.

Stirling.—Prof. Kennedy is to be asked to meet the Electric Lighting Committee at an early date to make arrangements in regard to his scheme for electric lighting, which the Commissioners have already resolved to proceed with.

Stretford.—The District Council having resolved to put down an installation, is asking Urmston District Council whether it will take a supply of current from it for the lighting of that district.

Sutton Coldfield.—The Town Council has decided to apply to the Board of Trade for a provisional order for electric lighting.

Taunton.—During August the equivalent of 524 8-candle-power lamps were connected.

Valladolid.—It is stated that the electric works at Valladolid were set on fire on Friday evening by a flash of lightning and partially destroyed, shops and theatres having to be closed in consequence.

Walker.—The District Council will apply for a provisional order.

Walsall.—At the monthly meeting of the Town Council on Monday, the Electric Lighting Committee reported that the number of consumers was 111, and the total units generated during the month of August was 11,030. The committee recommended, and the Council resolved, that with a view to encouraging the use of electric motors, and to securing a day load for the generating plant, a special charge of 2½d. per unit be made for current supplied for motor purposes only.

Wimborne.—The District Council has referred the question of the electric lighting of the borough to the Electric Lighting Committee to report upon.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Berlin.—The *Electrotechnische Zeitschrift* of August 25th publishes a map of the complete system of electric street railways which will be finished within the next four to five years in Berlin. The total number of motor cars running will be 850 (of which 500 will be fitted with accumulators) and power consumed is estimated at 10,000 kilowatts, so that the total annual consumption of energy will exceed 20 million kilowatt-hours. The overhead network will be fed at about 50 different points, which will receive current by special out and return cables from the central station of the Berlin electricity works, each cable for every feeding point having the same section. When this system is completed Berlin will possess the largest and densest network of street railways in Europe.

Blantyre and Wishaw.—The Wishaw Commissioners had before them last week a proposal to construct an electric tramway between Blantyre and Wishaw, and they gave the matter their favourable consideration, remitting it to the Gas Committee for report.

Bradford.—At last week's City Council meeting the Tramways Committee recommended the Council to apply for powers for the construction of the following tramways:—(1) From Four Lane Ends to Thornton; (2) an extension of the existing Great Horton line from Morley Street, along Tyrrel Street, to Bridge Street; (3) an extension of the Great Horton line from the junction of Laisteridge Lane and Park Avenue, along Park Avenue, Little Horton Lane, and Southfield Lane, rejoining the existing line in Great Horton Road; (4) a new line from Tyrrel Street, along Thornton Road, Lister Hills Road, and Legrams Lane, to Lidget Green; (5) a new line commencing at Forster Square, and proceeding along Kirkgate, Westgate, White Abbey Road, Whetley Hill, and Toller Lane, to Duckworth Lane. The Clayton and Queensbury Urban District Councils had offered to construct the tramway extensions to their districts if the Bradford Corporation would rent them at 5¼ per cent. of their cost, but the Committee had refused to entertain any such proposals from any of the out-districts at a greater rent than 5 per cent. Mr. John Arnold seconded the motion. Alderman Cowgill referred to the results of the working of the Bolton Road and Great Horton electric tramways. Up to Sunday night the Bolton Road line had been in use for 44 days, and the receipts had been £751 15s. 4d.—equal to £17 1s. 8½d. per day. The mileage during that period had been 11,951, and the average receipts 1s. 3¼d. per mile. Of course, during the first few days that the line was opened the traffic was abnormally large, but of late it had settled down to what would prove, it was hoped, the normal level. The Great Horton line had been in operation 16 days up to Sunday night last, and the receipts during that period had been £583 8s. 3d. No doubt they would have been greater if enough cars had been available at the outset to cope with the traffic. Owing to the steep gradients, the committee had warned the drivers to be very cautious, and had prohibited them from trying to make up lost time on the down journey. In fact, the committee endeavoured to make the drivers travel down hill more slowly than they went up. The result was, however, that more cars were required than was at first expected, and whilst those cars were being obtained, some traffic was lost. During the 16 days that the line had been opened 7,338½ miles had been traversed, and the receipts had averaged 1s. 7d. per mile. Of course, during Horton Tide, the traffic had been very heavy. With regard to the projected extensions, some question had been raised with respect to the proposal to construct a line along Kirkgate. The committee, however, would not contemplate commencing any works of that kind until Kirkgate had been widened. It was only eight or nine yards in width between the buildings at certain points, and no man in his senses would think of constructing a tramline along a street so narrow. The minutes were agreed to.

Brentford.—The London United Tramway Company have intimated their intention of commencing breaking up the roads for the purpose of laying their new electric line to Hounslow, on October 1st. The Brentford District Council has resolved to withhold its assent until the company have deposited £5,000, a moiety of the cost of the widening of the High Street, which is one of the conditions of their undertaking.

Burnley.—A Corporation deputation inspected the Leeds electric tram system on 15th inst.

Cape Town.—Attention has been directed in the metropolis of Cape Colony to the desirability of constructing a railway, to be worked by electricity, up Table Mountain, which is 3,582 feet high.

Cassel.—The municipal authorities have sanctioned the installation of a battery of 280 accumulators with an output of 750 amperes for one hour, to be used in the working of the street railways. The battery, which has to be installed by the beginning of October, is to be supplied by the Accumulator Works of E. Schuls Witten a. d. Ruhr.

Christchurch.—The British Electric Traction Company does not intend to allow its electric traction scheme to drop.

City and South London Railway.—This railway company has given out a contract for the erection of its new engine and boiler houses, presumably for the purpose of its extended system, to Messrs. Whitehead & Co., Limited, the total being £10,749.

Dover.—At the Council meeting last week, the surveyor stated that he had prepared a few particulars regarding the first year's working of the trams, which he believed would be of interest. The two miles of main line were opened on September 6th last year, and Maxton line (one mile) at the end of December. The total receipts for the year were £7,487 15s. 3d. The receipts per car mile were 12·39d. The operating expenses per car mile, including all wages, staff, electric energy, &c., was 6·41d. He explained that this would have been 5·9d. per car mile had it not been that the Corporation had to pay £302 for current they did not use. The average receipts per day were £24 0s. 11·39d. The passengers carried numbered 1,794,903. The number of miles run was 144,864. In running each car mile ·95 of a Board of Trade unit of electricity was used. It was impossible to give the amount of the net profit, because all the bills were not in, and as it was not the end of the financial year, definite particulars could not be got out. But the Council might take it for granted that, after payment of £1,582 interest and instalment on loans, and all expenses of repairs, uniforms, &c., there would be at least £1,300 clear profit on the year. There were four tenders for the erection of a tramway workshop and fire escape shed at Maxton, the surveyor's estimate being £375. Mr. H. B. Ellis was the successful tenderer, £381 18s. 6d. The remaining tenders were Mr. J. Parsons, £439 12s. 2d.; Mr. G. Munro, £422 17s. 2d.; Messrs. Austin and Lewis, £389 8s.

Dudley.—As has been already stated in the columns of the Electrical Review, the Dudley portion of the proposed electric tramway remains in abeyance pending the Dudley Corporation and the British Electric Traction Company finally coming to terms; but that portion of the Dudley and Stourbridge line from Harts Hill to Stourbridge will be, it is expected, in full working order before the end of the year. The generating station at Harts Hill is being rapidly pushed forward by Messrs. Whittaker & Co., the contractors. It comprises a car shed 102 feet by 54 feet, a workshop 102 feet by 27 feet, a boiler house 49 feet by 48 feet, and an engine room 57 feet by 30 feet. The contract for the works amounts to £7,000. The site has been acquired from the Earl of Dudley, and sufficient space has been obtained to double the operations, if such expansions should be necessary. There will be two large Lancashire boilers capable of working up to 140 lbs. pressure on the square inch, two non-condensing compound engines, and two electrical generators. There are to be nine cars capable of carrying 28 passengers in each. Each car will be fitted with two motors, rated up to 25 H.P., geared to the axles. The span wire system will be utilised. Enough power, it is stated, could be generated at the station to work the whole of the original system, viz., from Dudley to Kinver, *viâ* Kingswinford, from Dudley to Stourbridge, *viâ* Brierley Hill, and from Dudley to Cradley Heath, as well as provide for the lighting of the district if required. At present the line will be 3¼ miles in length, and it has been entirely reconstructed. It is proposed to run a 10 minutes' service of cars; but if some arrangement is not come to between the Dudley Corporation and the company, passengers

from Dudley to Stourbridge will be compelled to change from the steam trams at Hart's Hill and board the electric cars for the remainder of the journey. It is hoped, however, that the necessity of doing this may be averted.

It is expected that electric cars will also be running from Round Oak to Stourbridge before Christmas. Messrs. Dick, Kerr & Co. are well forward with the relaying of the permanent way, and the overhead electric equipment is approaching completion. The electrical power station, which adjoins the Great Western Railway on the Hart's Hill side, is being erected by Messrs. Whittaker & Co., of Dublin, at a cost of £6,000, from the plans of Mr. T. Robinson, of Stourbridge. Accommodation is provided in the boiler house for four large boilers (by Messrs. Danks), two with a capacity of 200 H.P. There will be two 175-H.P. engines, which will be coupled to electric generators, and room has been made for a third set. The electrical equipment and rolling stock are being supplied by the Thomson-Houston Company. The cars are seated for 28 passengers, and are provided with ordinary and emergency brakes. As regards the section of the line within the borough of Dudley, the draft agreement provides for the supply of motive power to the company by the Dudley Town Council. New lines are to be run from Dudley to Old Hill *viâ* Netherton, from Springsmire to Kingswinford, and from Stourbridge to Kinver.

Dundalk.—The agreement between the Electric Tramways Company, which was recently formed, and the Town Commissioners with respect to electric tramways and electric lighting, has not yet been settled. The company now puts forward an alternative proposition that the Commissioners shall do the lighting of the town and supply the company with the necessary current for its tramway, so that the financial advantages of the scheme may not be altogether lost to the town. Representatives of the company will confer with the Commissioners.

Dundee.—The Tramways Committee of the Dundee Town Council had another conference on the 16th inst. with the promoters of the Broughty Ferry light railway, with the result that a provisional agreement was adopted. The company do not now bind the Corporation to the overhead trolley system of electric traction. The railway has to be made within two years after confirmation of the order; no Sunday traffic will be engaged in except by agreement of both parties, and, in the event of the boundary of Dundee being extended, the railway will be transferred to the Corporation. As a guarantee that they shall fulfil their obligations, the company enter into a bond for payment to the Corporation of a sum equal to 5 per cent. upon the estimated cost of the railway.

Glasgow.—A representative of the *Glasgow Daily Record* learns from a member of the Corporation Tramways Committee that there is not much likelihood of the electric cars being started on the Springburn route before the beginning of October.

Grays.—At the last District Council meeting the town clerk read a letter received from the Drake & Gorham Electric Power and Traction Company, Limited. Mr. J. F. Albright, managing director, offered to attend and explain an electric tramway scheme which the company proposed carrying out, including the acquisition of the Gravesend, Rosherville, and Northfleet tramways and their electrical equipment.

Halifax.—The Electricity Committee are stated to have under consideration the desirability of adopting the steam turbine for the purpose of driving the generating plant for the electric tramways, and on Thursday last week a sub-committee went to Newcastle in order to visit the works of Messrs. Parsons. The committee have come to no definite decision as to the adoption of the turbine, but the matter will probably be decided this week.

Johannesburg.—By the last mail we learn that a new scheme is before the Government for the concession of an electric tramway, it having been submitted by some of the parties who opposed last year's scheme. A draft contract has been concluded, which provides that from the Market Square the contractor shall have the right to proceed 25 miles east along the reef, and 25 miles west, with an area of eight miles north or south from any point of the two lines. A clause provides that when the Government shall deem it necessary for an extension outside the boundaries, then the Government shall guarantee interest at the rate of 6 per cent. per annum, and shall make good any loss. Article 44 provides that the Government can expropriate trams, &c., after 15 years, after giving 12 months' notice to that effect. Failing to give such notice, the contract is to remain valid for another 10 years, when the Government can again take over, and then only after 12 months' notice. Failing to give such notice, the contract becomes valid for another 10 years. The only security the Government will get will be a deposit of £1,000, as against £5,000 deposited by the former would-be concessionaires.

The Jungfrau Electric Railway.—A Reuter despatch from Wengern Alp says that the first section of this railway was opened on Monday morning. The ceremony was attended by a company of 450 persons, specially invited by President Guyer-Zeller, who had a pleasant journey by the new line from the Scheidegg to the Eiger glacier. The railway is worked by electricity. Amongst the guests were representatives of various countries, including the British Minister to Switzerland. Luncheon was served at the foot of the Eiger glacier. When the line is completed, it is intended to build an observatory at the summit of the Jungfrau. At the banquet given to celebrate the opening of the line, Mr. F. R. St. John, the British Minister, proposed a toast to the prosperity of the undertaking. President Guyer-Zeller stated that the summit of the Jungfrau would be reached in 1904. The next section will carry the line as far as the Mönch.

Kidderminster-Stourport.—The *London Gazette* of Tuesday last contains a copy of the bye-laws and regulations which have been made by the Town Council in regard to the Kidderminster and Stourport electric tramway.

Leamington.—The Town Council is applying for a provisional order to light the town with electricity; but meanwhile the Midland Electric Light Company, which already supplies numerous private consumers in Leamington, and is in possession of the field, is laying down new mains. The British Electric Traction Company, and the Warwick and Leamington Tramways Company, are agitating at the same time for permission to reconstruct the trams now plying between Warwick and Leamington, by substituting in place of horse traction the electric overhead system; but to this method the powers that be are unanimously opposed.

Leeds.—A special meeting of the Council will be held to sanction application by the Tramways Sub-committee for a provisional order for tramway extensions to the city boundary at Stanningley.

Light Railway.—Plans for a new light railway to run from Dover along the Eastward Cliffs to Martin Mill, near St. Margaret's Bay, have been submitted to the Dover District Council. The railway is to cross three public roads on the level, one of which affects the Kent County Council, and the matter had, therefore, to be deferred for submission to their surveyor.

Liverpool.—The City Council will shortly carry out some extensions of its proposed electric tramway system. One of these extensions is estimated to cost about £14,000.

Middlesbrough.—It is said that so great has been the success of the Teesside electric tramways that Mr. Clifton Robinson, the managing director of the company, has received applications from several public bodies in the neighbourhood desiring the extension of the system, and next month the company propose to apply to the Light Railways Commissioners to authorise extensions in several directions. The contemplated extensions are to the east of their present system, through North Ormesby and South Bank to Grove Hill, and in Stockton, westward along Yarm Road to Eaglescliffe Station. It is intended that the extensions should be constructed, equipped, and operated exactly as the existing electric tramways on Teesside.

Newcastle.—On Tuesday, the sub-committee of the New Tramways Committee went into the details in the expert reports regarding proposed new tramways. The sub-committee came to the conclusion that on a 2½ minutes' service, the profitable working was altogether in favour of the cable system. The catastrophe on the electric tramways at Bradford was felt to be a clear indication against the experiment being tried on the slopes of the west end of Newcastle. The whole matter will be discussed at a full meeting to-day, Friday.

Paisley.—The Town Council in committee considered last week the offers of the Glasgow Corporation Tramway Committee and the British Electric Traction Company, Limited, with reference to the control of the tramways in the burgh. It would seem that the Glasgow Tramway Committee have greatly extended their original offer, and made it much more acceptable to the Paisley Council. In any case, it was agreed by 16 votes to 4, to accept the terms offered by Glasgow as against the scheme of the Traction Company, to lay down lines connecting the burgh with Glasgow, Renfrew, Johnstone, and surrounding places. It is understood that under the arrangements which have been accepted, the Glasgow Corporation are willing to advance the money to buy up the present tramway system and relay the lines for electric traction, the lines to be handed over to Paisley Corporation free at the end of 33 years. They will equip the line from Glasgow to Paisley and supply the cars, and are willing to co-operate in furnishing contributing lines throughout the town. A guarantee is given that the main line will be in working condition within three years, with the same facilities and terms to passengers as are presently given in the city. Wherever the width of the street or the road will permit, they are prepared to lay a double line. Of course, it is understood that the offer is conditional on the Glasgow Corporation obtaining the proposed powers from Parliament in the Bill which they have decided to promote.

Portsmouth.—Satisfactory progress has been made with the additional works at the electric lighting station, and the Committee would soon be able, by utilising the accumulator to store sufficient electric energy, to run 25 cars on the main tramway system. In view of the acquisition of the lines by the Corporation, under the Act passed last session, a special committee will visit several towns where electric traction is in vogue, with a view of introducing the most effective system into Portsmouth. The date has not yet been fixed for this trip. The machinery at the lighting station is now more than sufficient to meet all possible demands for the electric light for a long time to come, and local electricians are busily engaged in wiring business houses, places of worship, and private dwellings.

Pwllheli.—An electric tramway is proposed for Pwllheli—along the embankment of the charming watering place. The matter has been referred to a Provisional Committee.

Sculcoates.—Messrs. A. M. Jackson & Co. have written to the Sculcoates District Council, stating that some influential clients had in contemplation a plan for the building of an electric tramway from Hessle to connect with the new system in Hull. It was resolved to leave the matter with the chairman, deputy-chairman, the two Hessle representatives, and Dr. Wilson Barkworth, that they might meet and discuss the scheme with the promoters and their solicitors.

Sheffield.—At last week's City Council meeting, a statement was made showing the progress that is being made with the various tramway extensions. The Tramway Committee says that it is proceeding with the work as quickly as possible, notwithstanding the complaints of numerous grumblers.

Southampton.—Messrs. Kincaid, Waller and Manville recently reported upon their examination of certain of the tramways. They recommend the construction of an additional short length of line, the reconstruction of portion of the existing line. In their estimate of the cost they have included the bonding of the rails for electric traction. The following is a list of the materials that will be required:—Two sets of points and crossings and heel pieces; 37 Edison-Brown plastic bonds; 37 Chicago bonds; 12 cross bonds; 380 square yards of granite paving setts, 4 inches wide by 5 inches deep; 570 square yards of wood paving blocks, 4 inches wide by 6 inches deep; together with the necessary cement for concrete and grouting. The Tramways Committee resolved that Messrs Duke and Co., of Plymouth, be requested to submit a tender for the re-laying of the tramline between Fourposts Hill and Waterloo Road, in accordance with the specification prepared by Messrs. Kincaid, Waller and Manville.

Swanscombe.—The District Council has been discussing a letter from the Drake & Gorham Electric Power and Traction (Pioneer) Syndicate, Limited, asking whether, in the event of the syndicate acquiring the Gravesend, Rosherville, and Northfleet tramways for the purpose of extending the system and working it by electric traction on the overhead system, the Council would assent to their application for a provisional order for that purpose, and would undertake not to exercise any right the Council possess under the Tramways Act to purchase the existing undertaking for 28 years.

Swansea.—The British Electric Traction Company has abandoned its intention to seek powers to make further extensions of its line in Swansea on account of opposition from the County Council.

Sunderland.—The special meeting of the Town Council to receive a report from the Tramways Committee was held on Wednesday. The committee recommended the purchase of the existing system from the Sunderland Tramways, Limited, and the institution by the Council themselves of a system of electrical traction with overhead wires. The committee also submitted a number of proposals from the present company, who are willing to substitute electrical traction for horse haulage, and to furnish a number of totally new routes. They are not, however, prepared to pay what the committee ask for service from the Corporation electrical supply. This is 2½d. per unit for a minimum of 350,000 units per annum; 2¼d. for a minimum of 500,000 units, or 2d. for a minimum of 700,000 units. The company offer 1½d. per unit for any quantity. The Council decided to purchase the trams and work them municipally. The overhead wire system was adopted, and the scheme will cost about £250,000.

Tramcar Collision.—It is stated that two cars on the Middlesbrough and Stockton electric system collided last Saturday morning on a single line on the Middlesbrough Road. A dense fog prevailed at the time. Several passengers were more or less seriously injured.

Tynemouth.—At last week's meeting of the Tynemouth Town Council, held at North Shields, the subject of proposed electric trams in the borough was again discussed. Negotiations were commenced between the Corporation and the British Electric Traction Company some time ago, but now the parties are at a deadlock regarding the maintenance of the roads under the new system. The Corporate authority had laid down definite demands, and the company have not seen their way clear to meet them, and at the present time both sides appear determined. There are no indications of modification on either side.

TELEGRAPH AND TELEPHONE NOTES.

Chinese Telegraphs.—A despatch from Shanghai reports that the French Minister at Peking is endeavouring to obtain control of the Chinese telegraph line from Sheng.

Glasgow Telephones.—The town clerk has received a letter from the Postmaster-General, in reply to Glasgow's renewed application for a Corporation telephone license, saying that the Government have under their serious consideration the report of the Select Committee on municipal telephones, and that it is unnecessary to receive any deputation meantime from the Corporation.

Reduction of Cable rates to Australia.—The following extract from a Sydney paper, *The Daily Telegraph*, just to hand, shows the present position as regards the proposed reduction of rates:—"The subsidy paid by the Australian colonies, with the exception of Queensland, to the Eastern Extension Company amounts to £32,000 per annum. The contract expires before the end of the year. At the Hobart Conference the question of a reduction in the rates came up for consideration, and it was decided that efforts should be made to secure this end. From the correspondence published below, and which has been furnished by the Postmaster-General (Mr. Cook), it will be seen that the company decline to discuss the question excepting on the basis of the colonies subsidising the new Cape cable. The reduction asked for is from 4s. 9d. per word to 4s., but an intimation has been received that the company are waiting before entertaining the proposal for the Governments of the Australian colonies to definitely decline to consider the proposals with regard to the Cape route. Mr. Cook states that so far as he knows the Governments have already decided on that point, and against the proposal. This was at the Premier's Conference in Melbourne. Under these circumstances the attitude of the company appears to the Postmaster-General to be, as he describes it, somewhat extraordinary. At the same time, he wishes the public to understand that every effort has been made to secure a reduction in the cable rates, irrespective of the Cape cable project, but so far without success. The following is the correspondence referred to:—

"Postal and Electric Telegraph Department, General Post Office, Sydney, April 14th, 1898.—Sir,—Referring to the understanding at Hobart last week that you would communicate further with your company in England regarding the question of a new agreement and reduction of cable rate between Australia and Great Britain, I am directed by the Postmaster-General to inquire whether the company is prepared to make any fresh proposals, irrespective, of course, of those in connection with the projected South African route.—I have, &c., S. H. Lambton, Deputy Postmaster-General.

"W. Warren, Esq., Manager in Australasia, E.E A. and C. Telegraph Company, Limited, Melbourne."

"The Eastern Extension, Australasia, and China Telegraph Company, Limited, Melbourne, April 20th, 1898.—Sir,—In acknowledging the receipt of your letter of the 14th inst., I have the honour to state that I made no promise to the honorable the Postmaster-General to communicate further with the company regarding the question of a new agreement and reduction of the cable rate. In reply to his inquiry, I am directed to say that the company have no further proposals to make other than those already submitted to the respective colonies for an alternate route *viâ* the Cape, and now await their decision respecting the same.—I have, &c., W. Warren, Manager in Australasia.

"S. H. Lambton, Esq., Deputy Postmaster-General, Post Office, Sydney."

In reply to further representations by Mr. Cook, Mr. Warren wrote on June 9th as follows:—

"Sir,—I have the honour to acknowledge the receipt of your letter, No. B2/98—2222, of the 8th inst., and to reply to state that my company cannot offer any opinion or advice respecting the proposal for reducing the tariff to 4s. until the Australian Governments definitely decide whether they will, or will not, take part in the Cape cable scheme. Should they definitely decide in the negative, my company will then be prepared to consider any proposals that may be submitted for a 4s. tariff.—I have, &c., W. Warren, Manager in Australasia." The following extract from an enclosure to a letter from Sir Sandford Fleming to Sir Wilfred Laurier, dated Ottawa, December 28th, 1897, with regard to the Eastern Extension Company will be interesting:—

"The Eastern Extension Company represents a combination of associated companies engaged in telegraph transmission between England and Australasia. The lines of the company comprise those of three amalgamated companies:—(1) The 'British Indian Extension,' from Madras to Singapore, with a share capital of £460,000. (2) The 'British Australian,' from Singapore to Australia, with a share capital of £540,000. (3) The 'China Submarine,' from Singapore to Hong Kong and Shanghai, with a share capital of £525,000 The combined share capital of these three companies amount to £1,525,000. On their amalgamation the united share capital, by a well-known process of 'watering' to the extent of £472,500, was increased nominally to £1,997,500. The united company, since known as the Eastern Extension Australasia and China Telegraph Company, Limited, has been exceedingly prosperous; it has paid 7 per cent. on the enlarged capital, equal to 9 per cent. on the original capital. An examination of the published statements establishes that it has, in addition, expended out of the profits earned no less a sum than £1,571,540 on extensions and other productive works, and there remains unexpended and undivided to-day a reserve of surplus profits amounting to £804,193. These figures establish that the Eastern Extension Company has become a remarkably profitable investment. It regularly pays good dividends, but the dividends are no guide to the profits made. It holds in reserve undivided profits far exceeding in amount the whole value of its cables between Asia and Australia. The accounts of the company for 1896 and the first half of 1897 show that the net profits actually earned during these periods amounted to 13 per cent. on the present capital, and 17 per cent. on the capital prior to its being watered."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies—		
Barbadoes-St. Vincent ...	Sept. 15th, 1898 ...	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898 ...	...
Accra-Kotonou	Aug. 8th, 1898 ...	...
Bolama-Bissao	June 31st, 1898 ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	Sept. 15th, 1898.
Perim-Assab	Sept. 13th, 1898 ...	...
Seychelles-Maurice	Sept. 18th, 1898 ...	...
Landlines.		
Majunga-Jananarive ...	Sept. 19th, 1898 ...	...

The Telephone Question.—The Shoreditch Vestry on Tuesday passed resolutions regarding the telephone service, and will send copies to Mr. R. W. Hanbury, the Telephone Committee chairman, to Lord Salisbury, the Duke of Norfolk, and the Chancellor of the Exchequer, as well as the local members of Parliament. Similar resolutions have been already passed by other local authorities. They are to the effect that the telephone service should be under the con-

trol of one party, that municipal competition is undesirable, and that the best thing that can be done is for the Post Office to purchase the entire undertaking of the National Company upon terms to be mutually arranged.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—October 3rd. The Corporation Market Committee is prepared to receive tenders for the installation of the necessary wires, fittings, &c., for the electric lighting of the public market. The current will be supplied from the town mains. Consulting engineers, Messrs. Lacey, Olirehugh and Sillar, 78, King Street, Manchester. See our "Official Notices" September 16th.

Belgium.—October 27th. The municipal authorities of Ghent are inviting tenders until October 27th for an installation of electric lighting in the new Flemish theatre in that town. Tenders to L'Hotel de Ville, Ghent, Belgium, from whence particulars may be obtained.

Bexhill.—September 28th. The District Council is inviting tenders for the supply of water-tube boilers, dynamos, and balancer, switchboards, accumulators, cables, pipes, arc lamps, and posts. Specifications, &c., from the consulting engineer, Mr. A. H. Preece, 39, Victoria Street, S.W.

Bridgewater. — September 27th. The Bridgewater Trustees invite tenders for the wiring, supply of fittings, lamps, &c., for the electric lighting of the Bridgewater House Picture Gallery, St. James's Park, S.W. Specifications from Messrs. O'Gorman and Cozens-Hardy, 66, Victoria Street. See our "Official Notices" this week for particulars.

Buckley.—The Buckley Urban District Council, Flintshire, is desirous of engaging an engineer to consult on the question of lighting the district by electricity. See our "Official Notices" this week for particulars.

Dundee.—October 3rd. The Gas Commissioners want tenders for the supply of lead-covered cables and underground conduits. Specifications, &c., from Mr. W. H. Tittensor, city electrical engineer. See our "Official Notices" this week.

General Post Office.—October 25th. The G.P.O. is inviting tenders (*a*) for the supply of red fir telegraph poles, to be delivered in London, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10 lbs. or 12 lbs. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1898-9. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E. Stuart, controller of stores.

Ghent.—October 29th. The Ghent Municipal Council is inviting tenders for the installation of the electric light at a new theatre. The work, says *Daily Tenders and Contracts*, has to be completed by June 1st, 1899 (a fine being imposed for every additional day to completion), and maintained for 12 months. Labour clause. The contract includes the supply and delivery of 1,337 incandescent lamps, 20 arc lamps, &c. All expenses for registering, stamps, notices, &c., which are estimated to cost 130 francs, to be paid by the contractor. A deposit of 8,000 francs is required, on which 2 per cent. will be paid after 60 days. Specifications seen with, and plans obtained, on payment of 40 francs, from M. Le Sécrétaire Communal (A. De Bruycker), Gand, or at the office of the paper mentioned above. Tenders, on stamped paper, registered, addressed as directed, with a certificate of deposit, to be posted by October 27th. The tenders will be opened at 11 a.m. on October 29th.

Hull.—September 29th. Tenders are wanted for the supply of steel roofs for the extension of the Corporation electric light station. For particulars write to the city engineer, Mr. A. E. White, at the Town Hall.

Ireland.—September 27th. The Great Northern Railway Company (Ireland) is inviting tenders for the construction of about two miles of tramway alongside the public road from Sutton to the Baily Post Office (Sutton and Howth Electric Tramway). Drawings and specimens at the office of the engineer-in-chief, Amiens Street Terminus, Dublin.

Kingston-upon-Hull.— October 27th. The Electric Lighting Committee invites tenders for the supply and erection of certain plant in connection with the electricity works, including high and low tension mains, casings, trench work, &c.; switchboard, continuous current rotary transformers, motor-generator, &c.; centrifugal pump, condenser (ejector type), steam pipes, &c. Electrical engineer, Mr. A. S. Barnard. See our "Official Notices" this week for particulars.

Kingston-upon-Hull.—September 30th. The Corporation want tenders for the supply of 45 electric motor cars, 20 trailers, 2 sprinkler cars, and 2 traversing platforms. Specifications from Mr. White, city engineer. See our "Official Notices" August 19th.

Leigh.—October 14th. The Electricity Committee want tenders for the supply and erection of steam dynamos, switchboard, accumulators, mains, meters, overhead crane, water softener, &c., for the electricity scheme. Particulars from the engineer, Mr. John Foster, Leigh, Lancs. See our "Official Notices" this week.

New South Wales.—October 17th. The New South Wales Government is, according to *Daily Tenders and Contracts*, inviting tenders for the supply for the Department of Posts and Telegraphs of a steam engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Further particulars, &c., obtained from, and tenders to, the Secretary, General Post Office, Sydney, N.S.W.

Plymouth.—October 6th. The Corporation want tenders for the supply of an enclosed (ironclad) continuous current motor, shunt wound, for 10 B.H.P. at 850—950 revolutions, for 520-volt circuit, complete with spare armature, starting switches, and resistances. Borough electrical engineer, Mr. J. H. Rider. See our "Official Notices" September 16th.

Portrane. — October 3rd. The Board of Control, Custom House, Dublin, is inviting estimates for the supply and erection of an electric light installation for Portrane Lunatic Asylum, County Dublin. See our "Official Notices," September 9th, for particulars.

Rathmines and Rathgar.—October 5th. The Electric Lighting Committee is inviting tenders for the supply and erection of Lancashire boilers, mechanical stokers and other boiler house plant, also high speed steam dynamos, condensing plant, overhead traveller, switchboard, underground cable work, cables, posts for incandescent street lighting, street lanterns, and incandescent lamps and meters. Consulting engineer, Mr. Robert Hammond. See our "Official Notices," September 9th, for further particulars.

Rotherham.—September 26th. Tenders are being invited, says *Daily Tenders and Contracts*, for the lighting of Thryberg Colliery, Rotherham, by electricity. Further particulars and permission to inspect obtained from Mr. W. Hargreaves, agent, Rothwell Kaign, Leeds. Tenders to Messrs. J. & J. Charlesworth, Limited, colliery proprietors, Milnes House, Wakefield.

Spain.—October 3rd. Tenders are being invited by the municipal authorities of Almagro (Ciudad Real) for the concession for the electric lighting of the town. Tenders to be sent to El Secretario del Ayuntamiento de Almaguo (Ciudad Real), Spain, from whence particulars may be obtained.

CLOSED.

Glasgow.—The following tenders have, according to the *Contract Journal*, been accepted, among others, for work, &c., in connection with the alteration of the light at Cumbrae Lighthouse from a fixed oil light to a flashing electric light, for the Clyde Lighthouses Trustees:—Electric plant, W. Dixon & Co., Glasgow, £920; additional gas engine and compressor, Campbell Gas Engine Company, £380.

Great Central Railway.—The tender of the Brockie-Pell Arc Lamp, Limited, has been accepted for the supply of over 300 of their patent arc lamps for the lighting of the new Great Central Railway.

NOTES.

Electricity Supplants Steam Locomotives.—There is, perhaps, nothing very new in the electrical equipment of the Buffalo and Lockport new railway, but it is a line which marks a distinct advance in electrical haulage, for it is an ordinary railway on which electric haulage has been established. The line is 25 miles long, and for 10 miles is quite straight. The trolley wire is carried on a double line of poles, 88 feet apart, except where an arm support is used. Power is taken from the Buffalo-Niagara power line. In the transformer room are two 500-H.P. rotary converters, and necessary static transformers and switchboards. There are 10 cars on the road, each with four G.E. motors of 52 rated H.P., or 208 H.P. per car. The company also own two 45-ton G.E. locomotives, each with four motors. Their speed is 15 miles per hour, and they have drawn 28 cars loaded. They are of the same type as those to be employed on one of the London railroads. A half-hour service is to be run, the time being one hour. Advantage of the new line is to be taken, also, to secure Niagara power being transmitted to Lockport for general, public and private use.

Correction.—In our recent description of the works of Messrs. Brown, Boveri & Co., at Baden, we stated that this firm had been in existence for nine years. This should be only seven years, and the works for only 6½ years.

The Fire at the Geneva Electricity Works.—We have already referred to the fire which occurred early this month at the Geneva Electricity Works. The plant at this station is hydro-electric, and when completed will comprise 15 turbines of 1,200 H.P. each, driving two-phase high tension alternators and continuous current dynamos. To meet the temporary demand of electric energy, five alternators only and the two exciters had been installed, with a provisional wooden switchboard. It was the latter which took fire. The fire communicated to the roof and subsequently burnt down the switchboard, the timber frame of the roof, and some scaffolding in the incomplete part of the building. Some offices, and the foreman's lodgings, separated from the switchboard by a wall, were also burnt down. The machinery suffered less damage. The two exciters, which were under the switchboard, are entirely out of use. Of the five alternators, one was undamaged, and is already doing its regular work. The four others require some repairing. Of the two alternators that were erecting, one was partly damaged. The hydraulic machinery is almost intact. The masonry of the building was not seriously damaged, and there will be very little alteration in the actual disposition of the plant. The remaining eight machines that are to utilise the power still at disposal are actually in construction. The permanent switchboard, entirely fireproof, had been ordered some months ago, and is going to be set up very shortly. The cause of the fire has not been entirely elucidated, the official inquest not being terminated. The accident is very probably due to the passing of the high tension current into the exciting circuit of one of the alternators. The exciting cable going from the machine to the switchboard was fixed directly on the wood, and passed, in one place, very near a high tension armoured cable. It is supposed that an arc sprang from the continuous current cable to the neighbouring high tension cable, the metallic envelope of which acted as return conductor to the defective machine, which must at the same time have had a contact between the primary circuit and the metallic frame. The fire spread so rapidly that the man in attendance at the switchboard could not switch off the exciting current of the alternators, but had to stop the direct current dynamos, thereby leaving the whole building without light and motive power to shut the water-gates. One of the alternators went on revolving while the building was on fire, and was only stopped when the fire was nearly out. This machine was the least damaged, and it is the one that resumed its work four days after the accident. We are indebted to M. J. Elmer, the chief of the electric lighting service, for these particulars.

Manchester Association of Engineers.—The syllabus of the "forty-third discussion session" of this Association is before us. Among the announcements are the following:—October 22nd, Mr. Henry Hodgson, Manchester, paper on "Some Points in Modern Steam Engine Practice"; February 11th, anniversary dinner; February 25th, Mr. J. S. Raworth, paper on "The Generation of and Electrical Distribution of Motive Power"; March 11th, paper by Mr. A. R. Bellamy, of Manchester, on "Gas Engines as Motive Power in Engineering Works." The meetings are held at 7 p.m. at the Grand Hotel, Aytoun Street, Manchester.

The Doe Primary Battery.—Since our article on page 440 went to press we have further considered the subject, and now desire to add a few additional comments. It seems odd that Messrs. Houston and Kennelly should have failed to notice when making their tests, and in the report thereon, that the bicycle lamp was running at about 1·5 watt per candle-power. If we are not mistaken, it was the ambition of Mr. Stepney Rawson, in the old days, to manufacture a lamp which would give a decently white light at 1 watt. Here we have one at ·65 watt, running at 1·5 watt per C.P. It appears to us that a syndicate should be formed, not so much for the battery as for the lamp; the battery may be an excellent one of its kind, as we have suggested elsewhere, but we think its performance is greatly due to the lamp employed.

Appointment.—Mr. J. A. Constable, of Fulham, has been appointed clerk of works to the Blackheath and Greenwich District Electric Light Company, Limited.

Electric Tramway Accident at Bradford.—The Great Horton line of the new municipal electric tramways, opened only a few weeks ago at Bradford, was on Monday the scene of a serious accident, which, up to the present, has resulted in one death and a number of cases of very serious injury. There was a very heavy traffic to the city for Barnum and Bailey's show, and on the service in question, which is worked by the Corporation itself, every effort was being made to cope with the public requirements by running cars frequently. The route is about three miles in length from the centre of the city to its outermost extremity. The line is a constant ascent and, at some points, the gradient is very steep indeed. Down this decline a car started about half-past ten o'clock, and about two-thirds of the way down, at a point where the gradient is very severe, it is said to have suddenly leaped forward in an alarming fashion, and, despite the efforts of several men as well as the driver and conductor to stop it, came at a fearful pace upon a curve turning the line sharply at right angles. At this point the car instantly left the rails, and, running on to the causeway, dashed into the boundary wall of the Grange Congregational Chapel, where it overturned. It was found that there were several cases of fractured skulls, concussion of the brain, and broken limbs. The ambulance was brought into use as quickly as possible, and four persons were taken to the Royal Infirmary. Hardly any of the passengers escaped some injury. The driver and conductor of the car were both so badly injured that they cannot give any coherent account of the circumstances, but it is feared that the accident will prove only too clearly that the brakes in use on the car were not sufficient, in wet weather, upon such a steep gradient. During the early stages of the service the Corporation officers came to the conclusion that there was some doubt as to the sufficiency of the brakes when the rails were slippery, and warnings were addressed to the drivers that they were to drive more slowly downhill than uphill. Although there are both hand brakes and electric brakes on the cars, a fortnight ago an extra contrivance, described as a "slipper brake," as already mentioned in the Electrical Review, was ordered for all the vehicles, but the apparatus had not yet come to hand. The driver whose car met with the accident has been in the employ of the Corporation since the service was started, and is stated to be one of the most careful men. Despite the panic temporarily occasioned, traffic was soon resumed, and was as heavy as it was previous to the accident. Major Cardew is to hold a Board of Trade inquiry into the accident.

It is stated that comment has been made in the district in regard to the announcement that the inquiry will be held by Major Cardew who only a month ago passed the line as satisfactory. The coroner's inquest was opened on Wednesday and adjourned after formal evidence had been given.

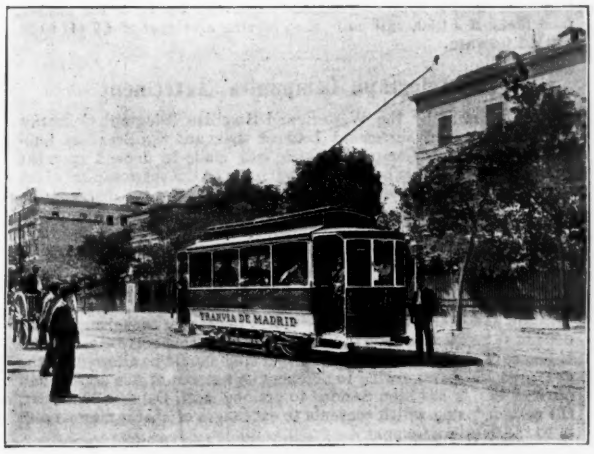
Obituary.—We regret to report the death of Mr. James Morton, the much respected business manager and secretary of Messrs. W. T. Glover & Co., Limited, at Salford, Manchester. The deceased, whose health had recently been impaired, was returning to his home late on Friday night by a rough footpath through some brickfields when he apparently missed the path, and, stumbling head foremost into a pool of water, was so stunned that he was unable to recover himself. His body was found next morning, face downwards, and partially immersed in the water. Mr. Morton, who was one of the oldest officials of the firm, before its conversion into a limited company, and who had been for the last 15 years in the same employment, was at once an intimately trusted servant of his employers, and a friend to all those beneath him. The funeral, which took place at Kersal Church on Wednesday afternoon, was attended by the directors, the staff, and most of the employés of the company, besides a large concourse of friends, and of the general public.

Lectures.—In conjunction with the London Society for the Extension of University Teaching, a course of 10 free lectures on "Electricity and its Modern Applications" will be given by Mr. F. Womack, M.B., B.Sc., at Sayes Court Institute, Deptford, on Thursday evenings, commencing October 6th.

The Leyton Destructor.—The *Surveyor* says that the county medical officer of health in his annual summary of the reports of the district medical officers of health, quotes the following as the conclusions of experts by whom the Leyton destructor was thoroughly tested as follows :—

(1) The destructor is capable of consuming wet sewage cake and house refuse of poor character in a complete and satisfactory manner; (2) the oxidation of the combustible matter in the material fed into the destructor is complete, and the gaseous products of combustion are inoffensive; (3) the gaseous products of combustion are sensibly free from any suspended matter by the time they pass into the flue in the chimney; (4) the clinker is well burnt and free from offensive half-charred carbonaceous matter. Even when working with a wet sewage cake and poor house refuse the destructor generates more heat than can be used with the present plant at Leyton. We examined one of the cells in its cold condition, and were unable to discover any signs of wear or abrasion. We therefore consider that your destructor provides an efficient and economical method of destroying the refuse of towns without injury to the neighbourhood. So far as we are aware, it is the only form of furnace yet adopted capable of burning a considerable proportion of sewage sludge, even when containing, as in this case, a high percentage of moisture.

Madrid Electric Tramway.—We give a photograph of the new electric tramways which have been recently constructed, and are now running, at Madrid. They are



operated on the trolley system. The contract for the equipment was entrusted to Messrs. Dick, Kerr & Co. Messrs. A. Dickinson & Co. acted as consulting engineers.

The Late Dr. Hopkinson.—At the Whitehaven Town Council, on Wednesday last week, the Mayor proposed a resolution of condolence with the family of the late Dr. Hopkinson, the consulting electrical engineer of the Corporation. The Mayor said he never knew a man with less "side." The Deputy-Mayor seconded the resolution; and as one who was more particularly in contact with him than perhaps any other member of the Council, said he could bear out what the Mayor said that for a man of his position in the scientific world it would be difficult to find one who was more unobtrusive or humble-minded than Dr. Hopkinson. Whitehaven had reason to be proud of his connection with the town, as he was proud of his connection with Whitehaven.

The Electrical Standardising, Testing, and Training Institution.—The Michaelmas term at the above Institution commenced on Wednesday, 21st inst. New editions of the following pamphlets relating to the Institution have just been issued :—Syllabus of course of training; Training of Electrical Engineers; Scale of Fees of the Standardising and Testing Department.

Wireless Telegraphy.—On Monday evening next, Mr. William Lynd is to lecture on this subject at the Queen's Park Institute, Harrow Road.

Smoke Comparisons.—We recently had occasion to professionally investigate and report upon a smoke nuisance in a country town, and for making comparisons of different intensities of smoke we made use of Prof. Ringelmann's smoke scale diagrams. Mr. Bryan Donkin, the well-known engineer, says in his new work, "The Heat Efficiency of Steam Boilers," that he has used the system, and considers it the best yet suggested for smoke trials, a statement we can thoroughly endorse. These diagrams can be obtained from Messrs. Charles Griffin & Co., Limited, publishers, of Exeter Street, Strand, W.C.

The Electro-Harmonic Society.—The thirteenth season of the Electro-Harmonic Society opens on Friday evening next at the St. James's Hall Restaurant as usual. The programme of the Smoking Concert includes songs by Messrs. Charles Chilley and Mr. Bantock Pierpoint; recitations by Mr. Ernest Meads; ventriloquial sketches by Mr. Sidney Gandy; silver bells solos by Mr. Harry Tipper, and "sensational novels" by Mr. Frederick Upton. Mr. A. E. Izard will render a pianoforte solo. The season may be expected to open with a goodly gathering of members and friends.

The West India Hurricane.—The West India and Panama Telegraph Company, Limited has sent a donation of 250 guineas to the Mansion House Relief Fund, and has arranged to transmit, free of charge, any telegrams addressed to the Governors and other officials of the West India Islands relating to donations and food supplies for the relief of the sufferers. Telegrams intended to be despatched should be sent to Mr. R. T. Brown, manager and secretary, at Dashwood House, E.C.

Rumoured American Amalgamation.—We give the following from the *Daily Chronicle* of 19th inst. for whatever it may be worth :—

Our New York correspondent telegraphs:—It was announced yesterday in Wall Street that the Walker Electric Company, of Cleveland, has been absorbed by the Westinghouse Electric Company. Several directors of the Walker concern will probably join the Westinghouse directorate.

Rails Warped by Expansion.—The *Street Railway Review* illustrates a length of line on the Fort Mayne electric railway which was caused to kink by the heat of the sun on July 8th last. The rails were laid on ordinary cross sleepers and were required to be uncovered to change the street levels. When uncovered they bent. This seems to show that rails when buried are so supported laterally that they merely compress in length, or that the effect of covering is such as to keep them much cooler.

Light-Electric Telegraphy.—Prof. Zickler, of Brünn, has conducted an elaborate series of experiments, which show that a telegraphic instrument can be actuated at considerable distances by a beam of ultra-violet light. He employs a powerful arc lamp as his transmitter, using a screen of glass to produce intermittent flashes of the ultra-violet beam, which embody themselves as dot and dash signals on his receiver. The receiver is an air-gap in a circuit containing an induction coil regulated to an E.M.F. just below the sparking point at the air-gap. As Hertz long ago has shown, a beam of ultra-violet light falling on the cathode of a strained air-gap, near its breaking down point, will immediately provoke a discharge. Zickler started by producing this effect over a distance of 2 m. Then, by improving the shape and material of his electrodes and enclosing them in a chamber of compressed air, he was able to increase this distance to 200 m. This is a remarkable result, and it is extremely interesting to physicists to learn that the short and easily absorbed ultra-violet light can influence a spark discharge at so great a distance; but, to think of this as a practical system of wireless telegraphy as Prof. Zickler appears to do, is a *reductio ad absurdum*. The light within the limits of the visible spectrum which an arc emits will do all the signalling that the ultra-violet beam is capable of, will penetrate to much greater distances, and can be manipulated with much simpler apparatus. The ether waves of the visible spectrum which Nature has successfully used for signalling since the creation are in danger of being rejected for our new ones, ultra-violet or Hertzian waves, which Nature probably long ago tried and found wanting.

Personal.—The directors of the Hôtel Cecil have appointed Mr. W. Poynton their chief engineer.

According to the *Ceylon Standard*, Mr. E. O. Walker, superintendent of Ceylon telegraphs, was to leave Colombo on September 5th to inspect the telegraphs in the southern and central province.

Mr. John Hart has accepted the position of manager to Messrs. Williamson & Joseph, Limited.

Appointment Vacant.—The Halifax Corporation want a borough electrical engineer with alternating current and electric tramway experience, at a salary of £300 per annum. See our "Official Notices" this week.

Side Lights on Cable Routes.—With reference to the article on page 441, we hear that the cable between Mauritius and the Seychelles Islands, for the laying of which the Eastern and South African Telegraph Company is receiving a large annual subsidy from the Imperial and Indian Governments, is at present totally interrupted.

NEW COMPANIES REGISTERED.

Edinburgh Collieries Company, Limited (4,002).—This company was registered at Edinburgh on September 12th, with a capital of £48,000 in £10 shares, to carry on the business of coalmasters, ironmasters, chemical manufacturers, engineers, electricians, general merchants, &c. The subscribers (with one share each) are:—Adam Nimmo, 12, Giles Street, Edinburgh, coalmaster; Richard Mackie, 56, Bernard Street, Leith, coal exporter; A. Naesmyth, Donibrielle Colliery, Cowdenbeath, coalmaster; Robert Moore, 156, St. Vincent Street, Glasgow, civil engineer; Henry Mungall, Cowdenbeath, coalmaster; H. Stewart, 6, Windsor Gardens, Musselburgh, manager; and Charles Carlow, Leven, coalmaster. The number of directors are not to be less than four nor more than 12; the first are Henry Mungall, James Dixon, Robert Moore, Charles Carlow, Alexander Naesmyth, and Adam Nimmo; qualification, £1,000; remuneration as the company may decide. Registered office, Waleyford by Musselburgh.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Edison & Swan United Electric Light Company, Limited (18,984).—This company's annual return was filed on August 19th, when 106,400 "A" and 23,564 "B" shares were taken up out of a capital of £1,000,000 in £5 shares. 17,139 "A" and all the "B" shares are considered as paid, 10,000 "A" are considered as having £3 per share paid, and 89,261 "A" are considered as having £2 10s. per share paid. 10s. per share has been called and paid on 89,261 "A" shares.

Globe Telegraph and Trust, Limited (7,465).—This company's annual return was filed on August 16th. The capital is £5,000,000 in £10 shares (250,000 preference); 180,042 preference and 180,227 ordinary have been taken up, and the full amount has been called and paid.

New Electricity Supply Syndicate, Limited (56,815).—This company's statutory return was filed on August 18th, when 35,000 shares were taken up out of a capital of £40,000 in £1 shares. 30,000 are considered as paid, and £1 per share has been called and paid on 5,000 shares.

British Electric Transformer Manufacturing Company, Limited (57,293).—This company's statutory return was filed on August 22nd, when 35,000 shares were taken up out of a capital of £50,000 in £1 shares. 20,000 are considered as paid, and 10s. per share has been called and paid on 15,000 shares.

Crompton & Co., Limited (27,200).—This company's annual return was filed on August 17th, when 32,098 shares were taken up out of a capital of £162,000 in £3 shares. 2,000 are considered as paid, and £3 per share has been called on the others. £89,624 has been paid, and £670 is in arrears.

CITY NOTES.

Rockhampton Gas and Coke Company, Limited.

The directors' report for the half-year ended June 30th, 1898, states that the result of the half-year's operations in both sections of the business shows an improvement. As regards the consumption of electricity, it is expected that during the current half-year a still further improvement will be manifested. A large number of remunerative extensions of mains and services have been made, and applications are in hand for further extensions, which, on approval, will be carried out at the earliest possible opportunity. The gas operations show a profit of £2,142 4s. 4d., which is an increase on the preceding half-year of £316 14s. 7d., and on the corresponding half-year of 1897 of £423 18s. 8d. The electrical operations show a profit of £190 2s., also indicating an improvement. The total profit (£4,332 6s. 2d.) from the two sections of the business has been placed to the credit of profit and loss (net revenue account). After providing for interest on debentures, &c., and dividend duty, a credit balance of £1,916 6s. 9d. remains, and from this the directors recommend the payment of a dividend at the rate of 7 per cent. per annum upon the ordinary shares, and 9 per cent. per annum upon the preference shares, amounting to £1,683 2s. 10d. free of dividend duty, and placing the balance (£233 3s. 11d.) to the credit of reserve fund for maintenance and improvement of plant.

Willans & Robinson, Limited.

The report of the directors of Willans & Robinson, Limited, for the half-year ended June 30th last, to be submitted at the general meeting to be held at the works, Rugby, on 5th prox., states that after writing off as depreciation from plant, patents, &c., the sum of £5,591, and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £2,013 brought forward) is £19,534. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 8 per cent. per annum upon the ordinary shares, together amounting to £9,476. The amount payable to the original directors, in accordance with the articles of association, is £2,616, leaving a balance of £7,441. From this the directors propose to carry £2,000 to the debenture redemption fund, and £3,000 to the reserve fund (against £1,500 last half-year), leaving a balance of £2,441 to be carried forward.

The Telegraph Companies' Agreement.

We are informed by the Western and Brazilian Telegraph Company that the proposed agreement between them and the Brazilian Submarine Telegraph Company, which was made to depend upon the assent of shareholders holding three-fourths of the share capital of the Western Company agreeing to exchange their shares for shares in the Brazilian Submarine Company, has now been ratified, the holders of considerably more than the required number of shares having signified their assent, and the agreement therefore enters into operation. Shareholders of the Western Company exchanging their shares will of course henceforth share equally in all dividends declared by the Brazilian Submarine Company in respect of profits accruing from July 1st last; Western and Brazilian Company's shares remaining unexchanged will depend as heretofore upon the profits earned by that company. In consequence of representations that further time should be allowed for the exchange of shares, owing to absences on account of the season and other causes, it has been decided to prolong, until October 20th next, the period during which consents to exchanges of shares may be sent in to the Western Company.

The Direct Spanish Telegraph Company, Limited.—The board has decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income-tax, on the ordinary shares, both for the half-year ended June 30th, 1898, and payable on October 1st next.

Royal Electric Company of Montreal.—It is stated that the directors have declared a dividend on the share capital for the quarter ended August 31st last of 2 per cent., being at the rate of 8 per cent. per annum, payable on and after 1st prox.

Evered & Co.—The directors have decided to pay an interim dividend at the rate of 7½ per cent. per annum for the half-year ended June 30th. Warrants will be posted on the 30th inst. The books are closed until October 1st.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending September 17th, 1898, were £3,384 16s. 8d.; corresponding period, 1897, £2,735 1s. 3d.; increase, £695 15s. 5d.

The City and South London Railway Company.—The receipts for the week ending September 19th, 1898, were £900; week ending September 19th, 1897, £866; increase, £4; total receipts for half-year, 1898, £11,388; corresponding period, 1897, £10,803; increase, £585.

The Dover Corporation Electric Tramways.—The receipts for the week ending September 17th, 1898, were £240 15s. 11d.; week ending September 18th, 1897, £136 0s. 9d.; increase, £104 15s. 2d.; total receipts to September 17th, 1898, £5,905 11s. 3d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for the week ending September 16th, 1898, were £1,025 9s. 9d.; corresponding week last year, £748 18s. 3d.; increase, £276 11s. 6d.; passengers carried, 147,986; corresponding week last year, 106,558; aggregate to date, £12,533 2s.; aggregate to date last year, £9,091 4s. 2d.; increase to date, £3,441 17s. 10d.; mileage open, 8 miles, as against 8 miles last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending September 18th, 1898, amounted to £1,595; corresponding week last year, £1,401; increase, £94.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending September 16th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,188.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Sept. 14th.	Closing Quotation, Sept. 21st.	Business done during week ended Sept. 21st, 1898. Highest.	Lowest.
137,400£	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
923,960£	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	63 — 66	65½	64½
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	116 —117	115½—116½	116⅝	116
3,038,020£	Do. do. Deferred	Stock	...	...	...	16 — 16½	15¾— 16¼	16 5/16	16 3/16
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¾— 16¼	15¾— 16¼	16 3/16	15¾
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	112	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	105⅞	105½
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	8½— 9½	8½— 9½	9	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	15 — 16	15 — 16	15⅞	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000	50	4½ %	4½ %	4½ %	103 —106%	103 —106%	...	...
60,710£	Direct United States Cable	20	2¼ %	2½ %	...	11½ — 12	11½ — 12	11¾	11 9/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100—103	100 —103	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½ %	6½ %	7 %	17¾— 18¼	17¾— 18¼	18 1/16	17⅞
1,295,000	Do. 3½% Pref. Stock	100	...	...	...	104 —107	105 —108	106	105½
89,900	Do. 5 % Debs., repayable August, 1899	100	5 %	5 %	5 %	100 —103	100 —103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	125 —129	126 —130	...	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	17½— 18	17½— 18	17⅞	17¾
25,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	99 —103	99 —103	...	...
100,500£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	124 —128	125 —129	127	125
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	102 —105	102 —105	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4⅛ %	4½ %	4½ %	12 — 12½	12 — 12½	12⅜	12 3/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	17¼	...
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	10 %	10 %	29 — 30	29 — 30	29½	...
160,000£	Do. do. do. do. 5 % Debs.	100	5 %	5 %	5 %	101 —104	101 —104	103¾	101¼
97,000	Halifax & Bermuda Cable, 4½% 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	100 —104	100 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	51 — 54	51 —54	53⅝	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	110 —113	110 —113	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000	5	4 %	4 %	4 %	2¼— 2⅜	2¼— 2⅜	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5⅜— 5⅝	5⅜— 5⅝	5 9/16	5 7/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	13½	13¼
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5½	5⅜
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100—105	100 —105	103½	103
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4⅜	4¼— 4⅜	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	103 —106	103 —106	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	nil	nil	3½— 4¼	3½— 4¼	...	...
213,400£	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	100¾	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ¼	⅛— ¼	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	104 —107	104 —107	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	12 — 12½	12 — 12½	12⅜	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	8⅛	...
33,129	Do. do. do. Def. Ord.	7½	1 %	nil	½ %	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	107 —110	107 —110	107½	...
88,321	West India and Panama Telegraph	10	¼ %	1 %	¾ %	1 — 1⅛	1 — 1⅛	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	9½— 9¾	9½— 9¾	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 — 8	6 — 8	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	105 —110	105 —110	...	...
160,100£	Do. do. do. 6 % Ster. Bonds	100	6 %	6 %	6 %	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6 5/16	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277	5	5 %	5 %	6 %	9 — 10	9 — 10	9½	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½ %	4½ %	4½ %	113 —115	113 —115	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25½	25⅜
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5	10	...	...	...	24 — 25	24 — 25	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	17⅛	16¾
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	125 — 130	125 —130	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	nil	13 — 14	13 — 14	13⅝	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £6 paid.	10	...	...	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	14⅞	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5 — 5½	5⅜	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	9½— 10½	9½— 10½	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17½— 18½	17 — 18 xd	17¾	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	116 —120	116 —120	117	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	15½— 16½	15½— 16½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	17 — 18	17 — 18	17⅝	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
50,000	Do. do. 4 % Deb. Stock Red.	Stock	...	...	4 %	105 —108	105 —108	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	7 %	9 %	12 %	16 — 17	16 — 17	16¾	16⅝

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Sept. 14th.	Closing Quotation Sept. 21st.	Business done during week ended Sept. 21st, 1898. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	2⅝— 2⅞	2¾— 3	2 13/16	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —102	96 —102	...	...
30,000	British Electric Traction	10	...	...	...	16½— 17	16½— 17	17⅛	17
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 14	13 — 14	13 13/16	13 11/16
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1⅝— 2	1⅝— 2 xd	2	1 11/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2⅜— 2⅜xd	2¼	2 3/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	107 —111 xd	107 —111	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102—105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	10— 11	10 — 11	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	108—111	110—113	112½	111¼
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10⅛	10⅜	10¼
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	6 3/16	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅜	1¼— 1⅜	1½	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4½— 5	4½— 5	...	...
630,000*l*	City and South London Railway	Stock	1 1/16 %	1 1/16 %	1⅛ %	70 — 72	70 — 72	71¼	70½
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £3 pd.	10	...	...	...	2¾— 3¼	2¾— 3¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1¾— 2¼	1¾— 2¼	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	89 — 94	89 — 94	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	6 %	2¼— 2¾	2¼— 2¾	2¼	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	101 —103	101 —103	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	2¾— 3¼	2¾— 3¼	2⅞	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	20½— 21½	20½— 21½	...	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	22½— 23½	22½— 23½	22⅝	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	103 —107	106¼	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10½— 10⅝	10 — 10¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16	15½— 16	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	39 — 43	39 — 43	40	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	100 —103	100 —103	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	126 —131	126 —131	129	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.

British Aluminium, Ordinary, 10½—11½; 7 % Pref., 12—13.

House-to-House, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 14—15; 1st Preference Cumulative 6%, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

London Electric Supply Corporation, £5 Ordinary, 3⅜—4.

National Electric Free Wiring, 10s. paid, ⅜—½.

*T. Parker, £10 (fully paid), 13—13½.

Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6%.

* From Birmingham Share List.

Bank rate of discount 2½ per cent. (June 30th, 1898).

MARKET QUOTATIONS, Wednesday, September 21st.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per ton	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£6 15	£6 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£14 10s.	£14	10s. inc.
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£17	£17	..
a Lead, Nitrate .. .. .. per ton	£23 10s.	£23 10s.	..
a „ White Sugar .. .. per ton	£30 10s.	£30 10s.	..
a „ Peroxide .. .. .. per ton	£27 10s.	£27 10s.	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	64/-	64/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 10	£6 10	..
a „ Recovered .. .. per ton	£5 10	£5 10	..
a „ Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£8 15	£8 15	..
a „ Crystals .. .. .. per ton	£8	£8	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2' to 12') basis per lb.	6¼d.	6¼d.	..
c „ Tube (brazed) .. .. per lb.	8¼d.	8¼d.	..
c „ Wire, basis .. .. per lb.	6¼d.	6¼d.	..
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£62	£62	..
g „ Wire (basis price) .. per lb.	7 1/16d.	7¼d.	..
g „ Sheet .. .. .. per ton	£62	£62	..
g „ Rod .. .. .. per ton	£62	£62	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	5/6	5/6	..
h India-rubber, Para fine .. per lb.	4/1½ forw'rd	4/1½ forw'rd	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	43/-	42/9	3d. inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	45/-	45/-	..
i „ Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£13	£13	..
g „ „ Sheet .. .. per ton	£13 17 6	£13 17 6	..
l Mica .. .. per lb.	5/6	5/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£7 9	£7 9	..
o Platinum .. .. per oz.	£2 16	£2 16	..
i Steel, Magnet, according to description .. .. .. per ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£76 10	£76 10	..
g „ foil .. .. per lb.	1/3	1/3	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
j „ Flax, 6 or 8 lea... .. per lb.	3¾d.	3¼d.	¼d. inc.
j „ Hemp, 8 ply 10 lbs. .. per lb.	3¼d.	3¼d.	..
j „ „ Russian, 10 lbs. per lb.	4¼d.	4¼d.	..
j „ Jute, 180 lbs. rove .. per ton	£11 10	£11	10s. inc.
j „ Manila, 24 thread .. per ton	£31	£31	..
k Zinc, Sheet (Vielle Montagne brand) .. .. .. per ton	£26	£25 10	10s. inc.

a Quotations supplied by Messrs. G. Beor & Co.
b „ „ „ The British Aluminium Co., Ltd.
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co. Ltd
g „ „ „ Messrs. James & Shakespeare.
h „ „ „ „ Jackson & Till.

i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ P. Ormiston & Sons.
o „ „ Johnson Matthey & Co.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

ON THE PACIFIC CABLE.

Read by Charles Bright, F.R.S.E., A.M.Inst.C.E., before Section G., *September 14th*.

The main object of this paper is to bring the subject once more to the fore. It is hoped, moreover, that by lightly touching on some of the main features of interest and importance, that a useful and interesting discussion will result in some sort of activity on the part of the British Association. An endeavour will be made to emphasise the fact that, notwithstanding the views that have been advanced in certain quarters, there are no engineering or electrical difficulties standing in the way of realisation. Let us first of all see what has been done in the matter up to date.

Various proposals for telegraphically spanning the Pacific Ocean have been brought forward for a number of years. As a matter of history we can even go back as far as the year 1870, when Cyrus Field and other American capitalists promoted a scheme for connecting California with China by way of Alaska and Japan. The route was, however, an impracticable one, partly on account of the prevalence of ice, partly owing to the difficulty of erecting and maintaining land-lines in connection therewith. Since then, Pacific cable projects have been developed in this country, from a national rather than from a private commercial standpoint. The route which has up to the present found most favour in the English mind is naturally that which connects British Columbia with Australasia, known as the "all-British" route. Her Majesty's Government and the Colonial Governments most concerned have been urged, from time to time, to consider the matter from a naval and strategic aspect. Finally, only two years ago, the Colonial Office called together a conference to thoroughly sift the question, advised by Mr. W. H. Preece, C.B., F.R.S., as consulting engineer. A number of experts were called to give evidence, and a report on the whole in favour of the line was duly arrived at, after a lengthy deliberation. Since then—so far as our country is concerned—inactivity has prevailed. And here ends a rough outline of what has gone before—or rather of that which has not, so far, got beyond the sphere of debate.

Let us now consider the matter under its different heads, partly by way of dealing with the various objections that have been raised from time to time, according to circumstances.

First then, it should be known that cables have been previously laid and repaired in depths over 3,000 fathoms. The 1869 Atlantic cable runs into about 3,200 fathoms, and this is only one of several examples of a similar depth. The deepest water in which the cable on the proposed route would be required to be submerged is 3,300 to 3,400 fathoms, near Fiji Island. There are indications of some 5,000 fathom depths in these latitudes, but well clear of the suggested cable line. The matter is touched on here, owing to the extraordinary statements that have gained currency, that the cable could never be laid—much less repaired—if only on account of the depths being so much greater than anything hitherto experienced.

Survey.—A sufficient knowledge of the nature and depths to be met with are already at hand to decide in favour of the possibility of the undertaking, and for the determination of the types of cable to be employed.

The portion of the route which more particularly requires a further and more detailed survey is that between the Fiji Islands and Australia on the one hand, and New Zealand on the other. I venture to think the series of soundings here involved could well be made on the return journey by the ship despatched to land the shore ends at the further points, immediately previous to laying the main sections.

Though many dark hints have been thrown out as to the unfavourable composition of the bottom by those who, perhaps naturally, do not want a Pacific cable, the statements are not supported by facts—so far as the actual route is concerned.

Type of Cable.—In designing a cable for the greatest depths to be met with, special care would of course require to be observed to adopt a type which would combine the requirements of safe laying from the contractor's point of view, with those of durability looked at from the aspect of the proprietor. The latter includes the necessity of the cable readily accommodating itself to any irregularities of the bottom, and, at the same time, being a good subject for recovery—not only when new, but also a number of years after submersion.

These interests are sometimes a little conflicting; naturally the most important point is to select a type which, if carefully and properly laid, will permit of being picked up several times over, and a number of years hence. Such a cable must be of a character which lends itself well to paying out with a sufficiency of slack to meet all subsequent cable operations.

Again, its specific gravity must be limited by considerations of recovery. When the difficulties of raising a cable to the surface in deep water first presented themselves in connection with Atlantic telegraphy, a low specific gravity cable was adopted with the special object of meeting these difficulties.* This type consisted of each iron wire being enveloped in Manila hemp. Such a cable is now, however, entirely ruled out of court as lacking in durability, and the result of experience all goes to show that, for types of this character, a close sheathed cable, with the iron wires more or less firmly butting against one another, is an almost *sine qud non*. Each wire would be separately coated with preservative compound, and covered with a thin cotton tape. Such a cable combines durability with a reduction of rigidity, which renders it well adapted to the general requirements of cable operations.

For the purposes of securing a given actual strength, the wires (which would, of course, be galvanised) must be made of homogeneous iron of the greatest possible breaking strain—now up to about 90 tons per square inch.

Having regard to pliability, there is a limit to the size of each wire; neither must they be below a certain gauge, with a view to durability after submergence.

The outside covering of the cable should be composed of compounded hemp cords or of jute (or hemp) yarns—in preference to canvas tape—on account of having greater durability, and as binding the whole cable together more firmly and permanently.

For recovery purposes (from a skin-friction point of view) the outside circumference of the cable should not be greater than is absolutely necessary to meet other qualifications, and, in some respects, the same remark holds good from an efficient laying point of view.

Finally, a smooth outside surface is of more importance in this sense than might be supposed.

On the other hand, as the author has previously suggested, a flexible riband sheathing of aluminium bronze, with substantial washers on each side, might with advantage be adopted instead of iron wires, thereby enormously reducing the weight, and imparting freedom from corrosion—in the event of an abnormally large core being employed. The riband—$\frac{1}{4}$-inch in breadth—would be laid with a very long lay, with a small turn between the edges, sufficient to allow a slight play. The low specific gravity of aluminium and its alloys is an obvious point in its favour, provided that it will support an equal length of itself, and that it is equally durable. It permits a much greater length being carried by a given ship, besides taxing the machinery less.

Aluminium bronze is suggested in preference to aluminium, on account of its much greater strength. It has, in fact, about six times the breaking strain, and very nearly the same as that of steel, while it has a weight scarcely a third of iron. Aluminium is only equalled by copper as regards pliability. It will be readily understood, therefore, that this renders it—or any alloy of it—admirably suited for the sheathing of a submarine cable.

The riband form is preferred on account of the increased flexibility thereby ensured in a large cable. It is on these grounds, moreover, that the metal tape is not allowed to overlap, or even to meet. Again, such a taping could, under no circumstances, damage the case under tension or pressure.

Laying.—For paying out the cable efficiently in the deepest water, special attention would have to be observed to the character of the brake apparatus; and if the ordinary friction brakes now in vogue can be supplanted by something more free from the chances of undue heating, an advance will have been made. Such an innovation would be especially valuable in this connection on account of the length of one of the sections—that between Vancouver and Fanning Island—being considerably greater than anything previously dealt with. This section, with a proper allowance for slack, &c., would run into some 3,500 nautical miles, or more, as against 2,717 nautical miles for the Brest-St. Pierre cable of 1869, the new French Atlantic line just laid being materially longer.

The brakes and holding back gear must, again, be of a character that will allow of rapid changes in the retarding force. They must also be of ample strength to prevent what would be a comparatively heavy cable from running away in the deep water, and coiling itself at the bottom, so to form kinks when afterwards being lifted.

Repairing.—It has been argued by some that, if a cable were ever laid on the suggested route, it could not be subsequently recovered. In reply to this contention, it may be pointed out that cables have already been picked up and repaired in depths of over 3,000 fathoms in the open sea. This, not of course on a single bight, but by first cutting it at the bottom, and then, having thus taken a great part of the strain off, lifting the cable elsewhere. Such a system is, of course, capable of extension *ad libitum*, by buoying the line in festoons at different points, and in gradually increasing heights from the bottom, until the strain at another position is sufficiently low to permit of the bight being raised to the surface.

Again, objections have been raised as to the length of time taken in the recovery of a cable in such depths. It must, however, be borne in mind that cables have been picked up and repaired in upwards of 2,000 fathoms within the course of two or three days.

Electrical Working.—It has been asserted that if the Pacific line were laid, it would not work satisfactorily. This suggestion is not, however, in agreement with facts; though it is true that the maximum speed obtainable on the long section (say, 3,500 nautical miles) with a large core would be low as compared with that attained on the Atlantic cables, which are, of necessity, kept heavily burdened with traffic more or less continuously. Nevertheless, with a core of the same proportions as that adopted in the "Anglo-American" Company's last cable—650 lbs. copper to 400 lbs. gutta-percha—under ordinary conditions, a speed (in five letter words) could be attained up to the minimum required by the Canadian Government in 1894.*

The above would be by ordinary manual transmission, whereas all the latest improvements in machine transmission with curbing arrangements (as well as condensers) would naturally be applied with something like a 35 per cent. increase in the speed, not to mention the circumstances that the adoption of Muirhead's duplex system would nearly double the working capacity of the cable.

As a first venture the above cable would probably be sufficient

* At that time this type of cable was also in much favour from a *laying* point of view, owing to its low specific gravity tending to materially simplify the requirements in the way of holding back gear and brake power, the efficient working of which, in controlling the cable's egress was, for lack of experience, in some doubt.

* It should, however, be remembered that though seven letters is still often taken as the equivalent of a cable word, it nowadays more usually averages up to nine letters. Such discrepancies go to prove the futility of expressing a required speed in *words* only.

to meet the ends in view. It is conceivable that a larger core would be out of the question on the ground of cost. Moreover, increases in the dimensions made beyond this would have the effect of still further increasing the mechanical difficulties as regards a suitable type of sheathing.

Experiments have, it is believed, already been made on two Atlantic cables looped together to test this point of the possibility of working through a considerably greater length than that to be dealt with here, the results being perfectly satisfactory.

In the construction of the first cable to India (*vid* the Persian Gulf), Messrs. Bright & Clark, as engineers to the Indian Government, adopted a conductor in which four ordinary wires were drawn down, so as to form the four quadrants of a true circle with a ring outside to embrace the whole. By this means—with a given weight of copper—they reduced the electrostatic (inductive) capacity of the core without increasing the conductor resistance, the result being a very material increase in the attainable speed of signalling, whilst sufficiently maintaining the mechanical requirements as regards pliability, &c. Messrs. Siemens Bros. have since, to a great extent, approached a similar end in their compromise between the single solid wire and the strand conductor, and this has proved a great success on a number of Atlantic cables.

It would seem as though a plan of drawing the wires down to a smaller total area might in this undertaking be advantageously adopted. In the case of the Persian Gulf cable an economical method of securing any particular speed was not of the same vital importance. Moreover, in that instance, the length not being of an abnormal character, the extra cost of that type of conductor was probably scarcely made good by increased working value. Here, however, the author is of opinion that this plan would be found to more than repay the increase in initial cost, especially as it would also materially reduce the quantity of gutta-percha required to obtain the same minimum thickness throughout for fulfilling the mechanical as well as electrical qualifications, this being the *bête noir* in the cost of an ocean cable, as also in its design.

A moral is surely to be gleaned from the recent Spanish-American war, such as cannot fail to have an important bearing on the question of spanning the Pacific Ocean. Here, indeed, we have a striking suggestion of what we may expect as regards telegraphic interruption in the event of war with another European power, and a consideration of the prospects reveals the urgency of a system of telegraphy uniting the entire Empire without touching on foreign soil.

The present lines to India and Australia are as follows:—

1. Lisbon, Gibraltar, Malta, Egypt, and the Red Sea.
2. France, Italy, Greece, Egypt, and Red Sea.
3. France, Austria, Turkey, and Persian Gulf.
4. Germany, Black Sea, Turkey, and Persian Gulf.
5. Russia, Persia, and Persian Gulf.
6. Russia and coast of China.
7. Lisbon, or Cadiz, and the West and East Coasts of Africa, *vid* the Cape.

It may be added that our colonies have been known (comparatively recently) to be dependent on the Russian-Siberian landlines for communication with the mother country.

Viewing the proposed line as a necessity to meet the political requirements of the age, attention may be drawn to the circumstance that in the very fact of the great depth and length in the open sea lies a source of security for the cable from a strategic standpoint. In a depth of over 3,000 fathoms, a man-of-war, with all the implements ordinarily at her disposal, would experience considerable difficulty in interrupting such a line, especially if the precise route be unknown. On the other hand, a line submerged in shallow water is extremely prone to interruption of this character, as well as to that of a rough bottom.

Again, there are several ways in which cables can be—and have been—interrupted at, and near, the water's edge.

In introducing comparatively few landing places, the route under consideration would be, relatively speaking, free from the latter source of danger, especially as such stations would be (or should be) under our own Government surveillance, and away from the path of the foreigner.

But *any* scheme for further, and independently, reducing the chances of a total breakdown of telegraphic communication with our colonies can scarcely fail, in the interests of the Empire, to commend itself to all British subjects—no matter what the efficiency of the existing system may be.

With regard to the effect of the Pacific cable on the cost of telegraphic communication, it may be observed that whereas at present if anyone in Victoria, say, wishes to communicate with Canada, his message traverses about 12,000 miles and costs him 6s. a word. By a direct Pacific cable, this tariff would be reduced to about 2s. 6d., the length of line being little more than half. It may be added that the message would reach its destination within an hour, instead of taking sometimes nearly 24 hours to reach the hands of the individual to whom it is addressed.

With the immense commercial field of China about to be thrown open, it may be fairly surmised that if *we* do not span the Pacific soon in one direction or another, some other power will, and possibly obtain a naval supremacy there; thus no time should be lost in carrying the project through.

The French have actually laid what they term "the first link of the chain destined to connect Australasia with North America." Their Australasian landing is the French convict settlement of New Caledonia, and, it is said, that they do not care on what American territory they land.

We will now pass on to a scheme that appears to have been suggested by the Eastern Extension Telegraph Company as an alternative for the Pacific line, *i.e.*, their proposal to lay a system of all-British cables to the Cape and Australia *vid* Gibraltar and other important naval stations.

Though an admirable line in its way—if only as a superior duplication of existing systems—this proposed cable can scarcely be regarded as a substitute for the Pacific project. It does not meet the case from an Imperial and strategic standpoint, because it does not include in its scope the largest and most populous of all our colonies—the Dominion of Canada. Again, it passes through foreign waters; moreover, landing on the wrong side of Australia, it is largely dependent on the good behaviour of Australian landlines.

The weak point in the "all-British" line, as considered by the Colonial Office in 1896, is undoubtedly the landlines through Canada. But there is an alternative which in view of recent ideas will probably commend itself to many. If, in fact, a permanent and reliable understanding could be arrived at with our American cousins, any difficulties in the all-British Pacific cable scheme might be effectively overcome; still more, if that coming nation Japan were included in any such alliance.

It is known that the Americans are actively considering a project for a Pacific cable to Japan, *vid* Honolulu and various islands. A glance at the route reveals the fact that by a comparatively short branch to New Guinea the all-British interests could be combined with the Anglo-American-Japano, and that thus two Pacific cable schemes could be practically realised by one Pacific cable. Moreover, not only would the share of the cost to each country be enormously reduced, but the actual total cost would be materially less than in the case of the all-British route, owing to the long section therein being avoided such as involves an extra heavy core to obtain a fair working speed. A project of this character would do much towards more firmly binding together the two countries—and, indeed, all English-speaking countries—as the author has endeavoured to show in the course of an article in the current number of the *Fortnightly Review*.

In conclusion, with regard to the various schemes for a Pacific cable, it should be remembered that 40 years ago the feasibility of Atlantic telegraphy was the subject of incredulity—partly in Section A of the British Association meeting of 1855—at the hands of many of the greatest authorities until the cable was actually laid and worked in 1858. In that instance there was practically no data to go upon; whereas the proposed Pacific line may be regarded as but a further extension of what has already been done, though certainly involving special arrangements and precautions.

In this paper the author has only dealt with the technical side of submarine telegraphy in its present state of practice. If, however, some of the shining lights of Section A could get their ideas into shape, or on the basis of actual experiment, furnish us with new material, the whole difficulty, in a financial sense, might be solved at once.

By way of improving the present means of signalling upon cables, Mr. Oliver Heaviside, F.R.S., who treated the subject mathematically in the *Philosophical Magazine* in 1879, has advocated the introduction of both "leak" circuits and self-induction into cable lines. To put this idea in practice, electrical engineers, including Mr. Preece, Dr. Thompson, and others, have devised new forms for the insulated conductor, accompanied by devices which, to a certain extent, realise the said theoretical advantages. In some instances, however, the initial cost of these devices would prove an objection—even where otherwise practicable—and the only conclusion arrived at in regard to the application of leaks on the ordinary cable circuits of to-day is that when suitably disposed along the line, in obviating the choking effect of retardation, they secure increased definition for the signal, though not sufficiently to permit of any substantial increase in the working speed, even with the battery power raised within reason.

A number of other proposals have been made, but, so far as concerns any further substantial increase in the speed attainable for submarine telegraphy under given conditions, it seems probable that, if this is to be effected, it will be by an entire revolution in the form of conductor, dielectric and completed cable, rather than the signalling apparatus. The latter has probably reached its limit of sensitiveness. Any further increased sensibility of the instruments is likely to be at the expense of steadiness, and would tend to bring them within the range of influence of other surrounding forces. It is even now quite beyond that required or justified by the cable itself under present conditions.

ON THE ELECTROLYTIC CORROSION OF WATER AND GAS PIPES BY THE RETURN CURRENTS OF ELECTRIC TRAMWAYS.

By Dr. J. A. Fleming, F.R.S.

Read at a joint meeting of Section A and Section G, September 13th.

The subject of pipe corrosion by the earth return electric currents of electric tramways has at various times attracted a considerable amount of attention. There is no need to refer to the experience gained in the early days of electric traction, chiefly in the United States, which impressed on engineers the necessity for proper and efficient bonding of the rails in those cases in which they act as the return circuit. The British Board of Trade regulations now in force, under which electric traction is at present conducted in the United Kingdom, prescribe precisely the conditions for the use of uninsulated metallic return circuits, which are intended to prevent injurious electrolytic action on subterranean pipes. Amongst these rules an important one is the sixth regulation, in which the maximum permissible potential difference which may exist between a pipe and a portion of the neighbouring rail return is stated. In the case of an overhead electric tramway working with an earth return in which

the current returns to the generating station by the bonded rails assisted or not by return feeders, an electrical survey, made when cars are running, by measuring with a voltmeter the potential difference between the rails and any pipes buried in the earth in the neighbourhood, generally will reveal certain districts over which the tram line rails are positive to the buried pipes in their neighbourhood, that is, are at a higher potential. Certain other regions, usually near the generating station, will be discovered in which, on the other hand, the pipes are positive to the rails. The Board of Trade Regulation 6 (ii.) is as follows:—

"If at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in its vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return."

The above, translated out of official language, signifies that if the pipe is negative to the rail, the potential difference shall not exceed 4·5 volts, and if the pipe is positive to the rail, the potential difference shall not exceed 1·5 volt.

No matter what difference of potential may exist between a pipe and the neighbouring rail, it is well understood that electrolytic corrosion or damage can only ensue at any place under two conditions:—

(i.) The potential difference must create an electric current which leaves the pipe at that place, and

(ii.) The conduction through the surrounding soil, or at least into it, which thus takes place, must be electrolytic in character.

Hence, generally speaking, the *danger areas* are those in which the pipes are positive to the rails, and where a resulting current flows out of the pipe into adjacent electrolysable soil. Assuming then that the Board of Trade regulations are obeyed, the chief question of practical interest at present is to determine whether, under normal conditions of working, a potential difference of less than 1·5 volt between a pipe and the nearest part of an earth return, the pipe being positive to the return rail, is sufficient to cause an injurious action on the pipe by the production of electrolytic erosion. The matter is certainly largely determined by the nature and amount of the electrical conduction which can take place through ordinary soils, especially those which form the subsoil in towns and cities. Information has therefore been collected on this matter.

An experiment made in my laboratory with London clay taken from an opening in a London street made for laying down pipes, on December 14th, 1897, gave the following results:- The clay was packed into a dry, well-varnished wooden box, the interior measurements of which were: Depth = 27·3 cms., width = 18 0 cms., length = 61 cms. Two clean sheet-iron plates were placed at the ends of the box, the dimensions of each plate being as nearly as possible equal to the cross sectional area of the column of clay. Wires were soldered to these plates. The resistance of the mass of clay, 61 cms. in length and 491·4 sq. cms. in cross section, was found to be 194 ohms when measured with proper precautions in the usual way with the Wheatstone bridge and two dry cells. Keeping this electromotive force applied, the resistance soon rose to 277 and then to 283 ohms, indicating a progressive polarisation of the plates, and, therefore, an electrolytic conduction. A checking measurement was made also with the potentiometer, and it was found that a potential difference of 100 volts, created between the plates, produced a current of 0·52 ampere through the column of clay, thus indicating a total resistance of 194·5 ohms. These consistent figures show that the resistance of the clay in its then condition of moisture was approximately 1,566 ohms per centimetre cube, or nearly 17 ohms per yard cube.

The resistance proved, as might be expected, to be immensely dependent on the state of the clay as regards moisture, greatly increasing as the clay dried up.

A mass of damp sand, moistened with water slightly salt, was found to have a resistance approximately of 1 ohm per yard cube.

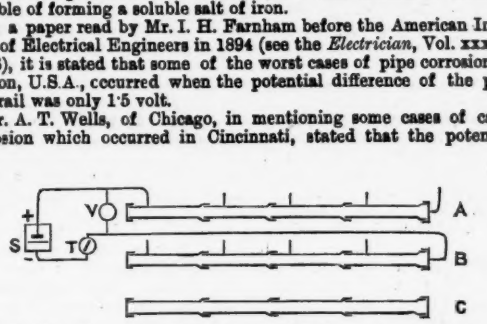
Experiments by Dr. St. Lindeck,* at the Reichsanstalt, in Berlin, in 1896, showed that cement blocks, after immersion in water for 22 hours, had a minimum electrical resistance of about 14 to 15 ohms per yard cube, but in their normal state a resistance of about 50 ohms per yard cube, and when specially dried by heating for 5½ hours to 100° C., a resistance of nearly 270 ohms per yard cube. The same investigator found that concrete (one part cement, five parts gravel), after being immersed for two hours in water, had a minimum resistance of about 25 ohms per yard cube, but, after being artificially dried for 4½ hours at 100° C., its resistance was of the order of 500,000 ohms per yard cube.

It has been frequently stated that concrete is a very bad conductor or fair insulator, and that rails laid on it are practically insulated, but the considerable decrease which takes place in the electrical resistance of materials such as clay, cement, concrete, sand and various soils, when impregnated with moisture, and the great increase which takes place when they are artificially dried indicates that the condition through them in their normal condition is largely due to the presence of water, and must, therefore, in great part at least, be electrolytic in character.

In the average condition of moisture most of the materials forming the subsoil in town and city streets are not likely to differ much in conductivity from the sample of London clay, damp sand or cement, tested as above described, and will probably have a specific resistance between 15 and 30 ohms per yard cube. Although the above specific resistance is large compared with that of metals, being of the order of 1,000 million times that of copper, yet between extensive metallic surfaces buried in the soil, the actual total electrical resistance may be numerically very small. Between two 100-yard lengths of 6 inch clean iron pipe placed in clay ground a yard apart, and, say, 2 feet deep, the actual measured resistance would in general be something of the order of 1 ohm. It is clear, therefore, that a continuously-applied voltage, not exceeding 1·5 volt, may cause the flow of very considerable quantities of electricity in the course of time between metallic surfaces of large area buried in the soil. Moreover, it is evident that a not inconsiderable portion, and perhaps the whole, of this flow must be carried by electrolytic conduction. In any case, whatever may be the nature of the actual road-bed on which the rails rest, the conduction out of the pipe will be in part electrolytic, if the pipe itself is in contact with ordinary soil. Under these circumstances the anode or pipe will be electrolytically attacked. Suppose that two iron plates or surfaces are placed in sand moistened with water, and having in it electrolysable salts, the acid radicles of which can attack iron. Let a current be made to flow from one plate to the other by creating a potential difference between them, then the passage of 1 ampere-hour out of the positive plate will remove or dissolve off from that plate 0 6968, or, say, 0 7 of a gramme of iron, if the metal is removed in the ferric state, or 1·04 grammes if in the ferrous state. Since there are 453·59 grammes in one pound (avoirdupois), and since the specific gravity of iron is about 7 8, it is easy to see that one cubic inch of iron may be removed from the positive plate by the electrolytic passage out of it of some electric quantity between 127·7 and 182·5 ampere-hours. This is, very roughly speaking, *one ampere-week*. The iron so electrolytically removed, may pass either into soluble iron salts, or may remain as an adherent layer of hydroxide. If chlorides, sulphates, or nitrates are present in the soil, the iron may be removed partly as ferrous or ferric salts which may be diffused through the surrounding soil, or wholly or in part converted into insoluble and adherent ferric hydroxide by secondary reactions. It is important to know the minimum voltage which will effect this electrolytic corrosion. If the surrounding soil is of a nature to favour electrolysis, that is, if moisture and salts are present in it, a far less difference of potential than the maximum of 1½ volt permitted by the Board of Trade can produce rapid corrosion of an iron anode or plate. To illustrate this fact, the following experiment was tried:—Two plates of sheet-iron were placed in a porcelain box filled with sand slightly moistened with salt water. The plates were kept at a difference of potential of 1 volt, and at such a distance apart that a current of $\frac{1}{10}$th of an ampere passed between them. At the end of 10 days the positive plate was very much corroded; the negative plate not at all. It has been found that the actual weight of iron removed may very much exceed the electro-chemical equivalent of the current passed, due, no doubt, to local action. This is shown by the following experiment:—Two iron plates were cleaned and weighed previously to being used, and then placed in moist sand containing a little salt. The plates had an immersed area of 11·4 square inches, and were 4·25 inches apart. A difference of potential of 1·5 to 1·8 volt was maintained between them for 23¼ hours. At the end of this period the positive plate was weighed, and found to have lost ·039 of a pound, or nearly two-thirds of an ounce. The electric quantity passed was only 8·14 ampere-hours. Theoretically, this quantity should have removed from 6 to 8 grammes, or nearly ¼ of an ounce from the positive plate. The actual loss was nearly three times that amount, and the excess is probably accounted for by the great local action taking place on the iron plate when oxidised in patches and placed in an electrolyte, the acid radicle of which is capable of forming a soluble salt of iron.

In a paper read by Mr. I. H. Farnham before the American Institute of Electrical Engineers in 1894 (see the *Electrician*, Vol. xxxiii., p. 16), it is stated that some of the worst cases of pipe corrosion in Boston, U.S.A., occurred when the potential difference of the pipe and rail was only 1·5 volt.

Mr. A. T. Wells, of Chicago, in mentioning some cases of cable corrosion which occurred in Cincinnati, stated that the potential between the rail and cable was never more than one half, and usually less than one quarter of a volt.



A, Positive pipe; B, Negative pipe; C, Neutral pipe; S, Secondary cell T, Ammeter; V, Voltmeter.

FIG. 1.

Mr. J. C. Lee, of Boston, states he has experimentally caused the corrosion of lead and iron by a difference of potential of one-hundredth of a volt.

I have myself produced in a few days sensible erosion of an iron anode placed in moist sea sand, the difference of potential between it and an iron cathode being less than half a volt and the current passing only ·03 of an ampere.

These experiments and others of a light character showed that quite small potential differences—much less than 1 volt—between iron surfaces buried in damp soils, especially if soluble chlorides are present, may bring about considerable electrolytic erosion in not very great periods of time, and that there is no absolute security in the limit of 1½ volt as imposed by the Board of Trade regulation No. 6 (ii). It was felt desirable to try an experiment on a somewhat larger scale and with actual water pipes buried in the soil. At my

* See *Electrician*, Vol. xxxvi., p. 788; also *Electrotechnische Zeitschrift*, March 19th, 1896.

suggestion, Mr. H. W. Pearson, the engineer of the Bristol Water Company, has carried out at the Bristol waterworks, at Chelvey, an experiment of the following character:—

Three rows of new ordinary cast-iron 5 inch water pipe (see fig. 1) were laid down in the ground, 1 yard apart. Each row consisted of four lengths of 9 feet pipe, or 36 feet in all. The lengths were jointed in the usual way with lead and the ends of the lengths were capped with cast-iron caps. In each pipe length was screwed a wrought-iron rod about 2 feet 6 inches in length.

These 36 feet lengths of pipe were buried in the ground 2 feet deep, just as if they were actual water pipes in use. The ends of the iron standards projected above the ground, and enabled an electrical connection to be made with the pipes at any length. The pipes when buried were clean new cast-iron pipes. Arrangements were then made to keep two adjacent rows of these pipes at a difference of potential of 1 volt night and day for six months. This was achieved by the use of a couple of large secondary cells charged alternately, and which were connected through an adjustible resistance with the two adjacent rows of pipes. A low reading ammeter and voltmeter was provided. The experiment was started on March 1st, 1898, and continued for six months. Daily readings were taken of the voltage between the pipes, the current passing between the pipes, and the nature of the weather. The electrical arrangements were placed under the charge of Mr. H. T. Sully.

The arrangement was then as follows:—One row of pipes was neutral, and simply laid down for comparison to observe the normal appearance of the pipes at the conclusion of the experiment. The other pair of pipes had a difference of electrical potential of 1 volt maintained between them constantly. All three rows of pipes were otherwise under similar conditions and buried in soil of the same kind—a non-acid, nearly neutral loam or sandy clay. The average current passing between the two active pipes was 0·15 of an ampere, and varied only between 0·1 and 0·2 of an ampere during the whole six months. At the end of the six months the pipes were opened up and carefully examined. The appearance of the pipes was very different. That pipe length which had been connected to the negative pole of the cell was a clean, grey colour, and had scarcely any trace of oxidation on it. It closely resembled the appearance of the pipe when first put in. The pipe length which had been connected to the positive pole of the cell was uniformly covered with a layer of orange-yellow oxide, or hydroxide of iron, in some places of quite sensible thickness, and easily detached. The pipe which had been neutral was oxidised slightly in places, but by no means uniformly. The experiment lasted 4,416 hours and 662 ampere-hours had passed from one pipe to the other under a constant voltage difference of 1 volt. The appearance of the pipes clearly indicated that electrolytic action had taken place. In the case of the negative pipe the clean appearance suggested that electrolytic hydrogen had been liberated against it and preserved it from oxidation by contact with the gases, water, and salts in the soil. In the case of the positive pipe, electrolytic action had clearly assisted or created oxidation. No actual perforations or pitting was found on the positive pipe, probable by reason of the fact that the electrical connections were so made as to facilitate as far as possible a uniform electric flow from one pipe to the other, not specially localised in one place. The actual electric quantity passed, viz., 662 ampere-hours, is theoretically equivalent to the removal of about 3·5 to 4 cubic inches of iron. Since the pipe had a length of 36 feet, and a diameter of 5 inches, its surface is approximately 6,500 square inches, or 45 square feet. Hence the oxidation of a comparatively small thickness of the iron uniformly all over the pipe would, electro-chemically speaking, account for the electric quantity passed. The difference between the two pipes amounted in effect to a greater rate of "ageing" of the positive pipe. It is, however, certain that if the electrolytic action, which, in this case, was tolerably uniformly diffused over the whole pipe surface, had been concentrated at one particular place, the erosion would have assumed a more serious aspect.

In the above-described experiment none of the conditions served to direct the exit of the current to one limited area on the positive pipe.

It is obvious that if under any conditions of electric traction there are differences of potential between the portions of a continuous pipe buried in the earth, the production of a current of conduction, and, therefore, perhaps electrolytic erosion is dependent upon the longitudinal conductive power of the pipes themselves. It has been stated above that ordinary subsoil resistance may be something of the order of 10 to 50 ohms per yard cube. The specific resistance of cast-iron is about 100 microhms per cubic centimetre, and would therefore be not far from one-millionth of an ohm per yard cube. It is therefore very easy to see that if it were not for the resistance introduced at the joints of the pipes and at the surfaces by rust or oxides, the conductivity of a cast-iron pipe would always be much greater than that of the soil which it displaces.

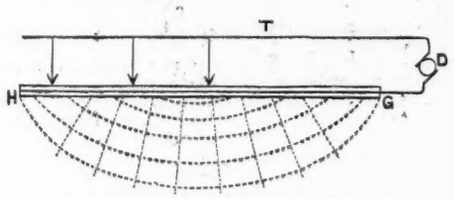
The resistance introduced, however, by bad or oxidised contacts, or by films of moisture, paint, or preservative compound, may altogether overbalance or outweigh the resistance of the mere run of the pipe material. I calculate that if there were no joints at all, the electrical resistance of 5-inch cast-iron water pipe would be about $\frac{1}{100}$th of an ohm per 100 yards, or, say, $\frac{1}{3}$rd of an ohm per mile. If leaded junctions are made in the usual way between fairly clean surfaces the joint resistance may not be large. In the case of the pipe experiment, above described, made at Chelvey, I measured at the end of the six months the total resistance of 27 feet of the 5 inch cast-iron pipe which had been the negative pipe. This length included two-leaded joints. The whole resistance was found not to exceed $\frac{1}{10}$th of an ohm.

It is obvious, however, that no general statements can be made. It is a matter of great difficulty to measure the resistance *per se* of a pipe buried in the ground, and it is probable that, whereas in some cases the conductivity of long lengths of water and gas pipes may be fairly small; in other cases, oxidised or electrically bad joints will introduce great resistance.

We have, however, to regard the subterranean pipes of all kinds as forming a network of conductors, interrupted more or less at places by junctions of high resistance; but, on the whole, most probably forming an irregular conductor system of greater conductivity than the soil or earth actually displaced by it, or which would occupy the same space if the pipes were not there.

Let us consider next the electrical conditions in the neighbourhood of an electrical overhead system of street railway. In all cases where the uninsulated tram rails are used as a return, it is unquestionable that some fraction—perhaps, a large one—of the return electric currents will come back through the earth from the distant or more remote portions of the track to those near the generating station, no matter how well bonded the track may be. The exact distribution of this current flow through the surrounding subsoil it is impossible to determine, but if there is a current at all, it involves as a corollary the existence of lines of current flow and orthogonal equi-potential surfaces.

We may roughly represent by a diagram the general electrical conditions, as in fig. 2. Suppose a generating station to be at D



H, G, earthed rail; T, trolley line; D, dynamos.

Fig. 2.

and T to be the trolley line and H G the rails. When cars are in operation, current is being discharged at various places into the line. The end H is at a higher potential than the end G. The Board of Trade regulations permit a maximum of 7 volts for this total rail fall. The result will be that through the earth we have a distribution of current flow lines, represented as to form only very roughly by the dotted lines in the diagram, terminating on the rails. The terminations of these lines accumulate near the places where the cars happen to be, and move with the cars. Orthogonally to these flow lines, or at right angles to them, there are equi-potential surfaces, which are shifting about in the earth as the cars move along. The disposition of the current lines will be modified by the presence of pipes in the ground, in so far as these are conductors, also by the electrolytic counter electromotive forces.

If, then, subterranean pipes exist in the region occupied by this return flow, and if these pipes have their extremities on different equi-potential surfaces, it is certain that current flow must take place through these pipes if they have any longitudinal conductivity, and no amount of conductivity in the soil, short of infinite conductivity, will altogether prevent this from happening. The proof of this is found in a very simple experiment. In a large vessel containing an electrolyte, say, dilute acid, two electrodes are inserted, by means of which a current can be passed through the liquid mass. Two lengths of insulated copper wire have their ends just stripped to lay bare the wire, and are then twisted together to within a couple of inches of the ends. These ends are spread out at right angles. The other extremities are connected to a galvanometer. If the spread out, bare ends of this galvanometer wire are dipped in the electrolyte, it will be found that a current passes through the galvanometer one way or the other, according to the position of the collecting end. If the spread end is placed so that it is at right angles to the line of the current flow, then no current will flow through the galvanometer. The explanation is, of course, obvious. If the extremities of the exploring wire lie on different equi-potential surfaces of the electrolyte when traversed by the current, the galvanometer, of course, indicates a current. If the ends lie on the same equi-potential surface, then the galvanometer indicates no current. After the test-wire has been employed in this manner it will be found that on stopping the main current the galvanometer gives a transitory reverse current, due to polarisation of the electrodes.

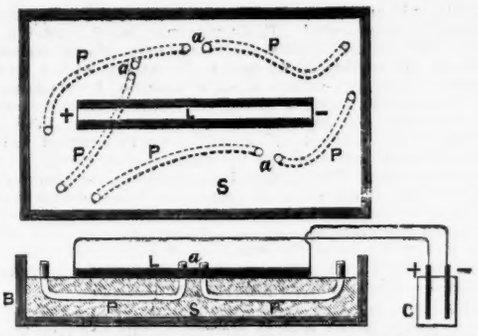
In the case of long electric street railways worked on the rail return system it is unquestionable that the difference of potential between the different portions of the track when cars are running involves as a certain consequence the flow of current through the earth, however efficiently the rail bonding may be carried out. Mr. H. F. Parshall has stated (*Proceedings of the Institution of Civil Engineers*, April, 1898) that in tests carried out on an eight-mile track, cutting the rails at the centre and inserting an ammeter, showed that 60 per cent. of the current was returning through the earth itself.

I think it will be agreed that it is exceedingly important, in the interests of other industries besides the electric traction industry, that in those cases where this earth flow occurs we should endeavour to find out where this current is going and what it is doing.

It is a matter of great difficulty to carry out experiments on actual electric street railway lines. We cannot always be cutting rails, and we certainly cannot cut gas and water pipes to ascertain the currents which may be flowing in them. I have, therefore, directed my attention to making a sort of working model of an electric traction system with an earth return, and of such a kind that pipes

or equivalent conductors can be buried, in desired positions, and an electrical survey made of the whole arrangement.

The model is made as follows:—A large wooden box, fig. 3, is provided, best made of paraffined or well-varnished deal. This box may be any desired size, but is best made square and of a depth equal to half the length or breadth. This box is filled with sea sand or river sand mixed with a little salt to give better conductivity and so compensate for limited dimensions, and the whole mass is moistened with water until it is thoroughly and uniformly damp but without free water on it. The resistance of such a mass will be about 1 ohm



B, wooden box; L, model tramline earthed rail return; C, secondary battery; P, buried lead or iron pipes brought out above surface at *a* to represent pipes; S, sand.

Fig. 3.

per yard cube between opposed surfaces. On the surface of this sand, which represents the earth, conductors can be laid down to imitate an electric tram-line. I have found it convenient to employ rods of plumbago and clay by which the required resistance and current carrying power is obtained. A pair of these rods connected in parallel by platinum wires may be laid down to imitate the line. A fall of potential along the line may be made equal to, say, 7 volts, or to the maximum fall permitted by the Board of Trade, by attaching the terminals to a battery of four or five secondary cells to the ends of the line. If an ammeter is included in this line circuit, it will be found that the total current taken is greater, when the rods are laid on the damp sand, than when they are bodily lifted up. This difference indicates the earth return current. In order to explore the distribution of current through the mass of the "earth," a galvanometer or voltmeter is provided, having flexible leads, and the ends of these attached to two insulated wires twisted together, the other extremities being bared and splayed out to form a sort of fork.

In the sand, then, can be buried, at a slight depth, thin iron or lead wires or tubes, to represent gas and water pipes, and these can be given any required form and arrangement.

An electrical survey can then be made with the voltmeter. If a "pipe" or wire representing a pipe runs nearly parallel to the "line" it will be found that at one end of the line, the "line" is positive to the pipe, and at the other that the pipe is positive to the "line" In my own model I have found that the potential differences of such a "pipe" and the line amount to 1 or 2 volts, just as they are found to do in the case of real electric street railways, when measurements are made between the rails and a parallel buried pipe.* In the case of the pipes running parallel to equi-potential surfaces, the potential differences between all parts of the pipe, and any one point of the line, are nearly the same. By means of the exploring or testing fork it is easy to show that the earth return current flows through the whole mass of the sand, and with a little trouble the general form of the equi-potential surfaces can be ascertained.

If the wires, as shown in fig. 3, representing "pipes" are bent so that they have a loop in them which emerges above ground, this loop can be cut, and a sensitive ammeter or galvanometer inserted, so as to indicate the current flowing through the "pipe." In this manner it can be proved that when a pipe runs approximately parallel to the track, and when it is found to be positive to the rails near the generating station, and negative to the rails at distant points, there is a current flowing in the pipe from the far end towards the station end. If the pipe runs more or less transversely to the line, then little or no current will appear in it.

In the case of actual pipes and real street railways, it is an impracticable matter to make such tests as shall show whether there is a current flowing in the pipe or not. We can only infer its existence when electrolytic corrosion has made its appearance.

From experiments made with the above model, I am led to believe that if pipes or wires were laid down imitating the form or arrangement of the actual main pipes, and if a track were laid down imitating the plan of the real track, that useful information might be gained as to the localities, if any, in which electrolytic trouble may be expected.

* If the "rails" in the model are made of carbon and the "pipes" are made of iron wire, there will be a constant potential difference between them of about 1 volt, due to the carbon, damp sand and iron forming a voltaic couple. This constant potential difference, however, can be taken into account in measurement, and does not interfere with the detection and measurement of those potential differences set up by the flow of current through the sand, which is originated by the external electromotive force.

It is, of course, obvious that a model on a limited scale can only very roughly represent the true state of affairs. In any actual case it is an exceedingly difficult, if not impossible, matter to predict the path along which the earth return current will distribute itself. It depends on unknown conditions as to rock and soil conductivity due to moisture, geological formations, subsoil water, infiltrations of sewage, brine springs, the conductive effect of buried pipes, leakage of water, gas, and the nature of the car traffic at the moment. There is, however, a drift of current through the earth from the most distant portions of the line towards that point or points where the negative dynamo terminals are attached to the rails. The question of pipe corrosion is wholly bound up with the degree to which this return current takes advantage of pipe conductivity to help it on its way, or is carried by the pipes as well as by the earth. This is not prevented by the fact that the earth resistance, taken as a whole, may be very much less than that of any line of pipe, but it is affected to a considerable degree by the resistance due to pipe junctions, or to the surface resistance afforded by oxidation of the pipes by which the entrance of current into them is hindered. The above statements can be proved by the use of wires imitating pipes badly jointed or partially insulated, and buried in the sand of the model electric railway just described, and a model of the above kind proves itself to be exceedingly useful for lecture or demonstration purposes in addition to its employment as a means of testing theories.

It appears, then, that the following statements may be taken as correctly representing facts, in the case of electric street railways having uninsulated rails used as a return circuit:—

(i.) No amount of bonding of the rails, if uninsulated, will entirely prevent the flow of current through the adjacent earth when there is any difference of potential between different parts of the line, and even with good modern bonding or even continuous rails a fraction, not inconsiderable, of the whole outgoing current may return by the earth.

(ii.) Some portion of this current will pass through subterranean pipes, the amount being determined by—

(*a*) The general or local subsoil conductivity.

(*b*) The electric conductivity and continuity of the pipe lengths and depending on joints and material.

(*c*) The length and disposition of pipe, and its position as regards the average equi-potential surfaces in the earth, when the line is working.

(*d*) The condition of the pipes as regards oxidation or incrustation with non-conducting oxides or protective covering.

The position which seems most likely to be favourable for the passage of current into the pipe is when it extends for some distance parallel with the rails and passes near the point of junction of the return feeder to the power station and the rails, and when it is new or fairly clean and well jointed; all conditioned, of course, by the general earth conductivity.

(iii.) The danger areas are those regions in which the pipe current, if it exists, leaves the pipe to get back into the rails or return feeder or even into the same pipe again, but mere difference of potential between the pipe and the rail is not in itself a source of danger to the pipe. There must be, in addition, electrolytic conduction of current out of the pipe into adjacent soil, which contains electrolysable salts and the necessary moisture.

(iv.) If electrolytic conduction out of the pipe exists at any places, there is no absolute security in the Board of Trade limit of 1·5 volt for the potential difference of pipe and rail, except in so far that the less the voltage, the less rapid will be the damage. Electrolytic corrosion may take place when only a small fraction of a volt difference of potential exists between the iron pipe and the adjacent portions of the rail return.

(v.) The conditions most to be feared as provocative of pipe destruction are when certain local soil conditions exist near the places where the pipe is most positive to the rail. The presence of soluble chlorides in the soil produced by presence of sewage, brine, springs, infiltration of sea water, if near the sea, solution of chlorides of sodium, potassium or magnesium, or other salts present in the soil produced by water due to pipe leakage or natural accumulation by rainfall saturating the soil, set up at once conditions permitting electrolytic conduction, and the resulting liberated acid or chlorine ions attack the cast-iron pipe. In rapidity of destruction under this action, a new clean pipe may possibly succumb even sooner than an old one protected by a dense adherent coating of oxide, which is not a very good conductor. The time which any such action takes to reach a stage destructive to the pipe will be obviously less the more the electrolytic action is concentrated on a limited area of pipe surface.

In designing an uninsulated rail return traction system, the probability of the above-mentioned conditions occurring should not be ignored. Even if actual perforation of the pipes does not occur, there may be an "ageing" action which shortens the life of the pipe.

(vi.) As the conditions determining possible pipe corrosion are numerous and not all easily predetermined, it is important in the case of every electric traction system with uninsulated earth returns, that an electrical survey should be made at intervals, setting down on a plan, showing rails and pipes, the potential differences between them at various places. Within the danger area a close watch can then be kept, whenever the ground is opened up for any purpose, for evidence of destructive electrolytic action on buried pipes.

In the above short summary of the causes and conditions of pipe electrolysis, no reference has been made to the question of remedy when it is found to exist. To deal with this portion of the subject properly would require more time than is at present at my disposal. All that has been here attempted is to show that, even working under Board of Trade regulations, it must not be assumed that the danger does not exist.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

18,894. "Improvements connected with electrical signalling or communication on railway trains." A. Shiels. Dated September 5th.

18,900. "Improvements in electric arc lamps." R. Frederick Hall. Dated September 5th.

18,907. "New and useful electric switch device for the temporary lighting of staircases, floors, cellars, and the like also for indicating the heating of shafts and bearings, and for fire-alarms." W. Blanckenhorn. Dated September 5th. (*Complete.*)

18,940. "Improvements in alternating current arc lamps." C. D. Abel. (H. O. Swoboda, United States.) Dated September 5th. (*Complete.*)

18,941. "Manufacture of homogeneous mixtures for the incandescence bodies of electrical glow lamps." C. D. Abel. (Allgemeine Electricitäts Gesellschaft, Germany.) Dated September 5th. (*Complete.*)

18,956. "Improvements in or connected with electrolytical condensers and electric current directing devices." C. Pollak. Dated September 5th.

18,958. "Improvements relating to the electrolytic decomposition of alkaline salts." E. Edser. Dated September 5th.

18,964. "An electric stop motion and tension device for warping and like purposes." A. E. Bancroft. Dated September 6th.

18,975. "An improved electric high and low tension fuse-head for blasting, mining, and the like purposes." W. H. Taylor. Dated September 6th. (*Complete.*)

18,981. "Electrical high voltage ceiling rose or cut-out." G. Bishop. Dated September 6th.

19,000. "Improvements in switching apparatus for controlling electrical motors." R. E. B. Crompton. Dated September 6th.

19,014. "Improvements in apparatus for starting electric motors." J. Burke. Dated September 6th. (*Complete.*)

19,015. "Improvements in dynamos." W. M. Mordey. Dated September 6th.

19,071. "An improved system of recording telephonic messages." W. Aitken. Dated September 7th.

19,076. "Improvements in wall connections for electric lighting." A. P. Lundberg and G. C. Lundberg. Dated September 7th.

19,116. "Improvements in or relating to shields or guards for the carbon pencils used in electric furnaces." J. Bastick. Dated September 8th.

19,140. "An improved electric arc lamp." H. V. James. Dated September 8th.

19,162. "Means and appliances for indicating at one end of an electric circuit the position of an arm or pointer at the other end of the circuit." P. Rabbidge. Dated September 8th.

19,243. "An improvement in fusible cut-outs for electric circuits." F. W. Francis. Dated September 9th.

19,246. "Improvement in systems of electrical distribution and regulation." B. G. Lamme. Dated September 9th. (Date applied for under Patents, &c., Act, 1883, Section 103, February 10th, 1898, being date of application in United States.)

19,248. "Improvements in alternating current electric motors." W. P. Thompson. (C. S. Bradley, United States.) Dated September 9th. (*Complete.*)

19,255. "Improvements in the covers or lids of sewer gas, electric, and telephone supply shafts, holes, gullies and the like, and in their supporting frameworks." J. Price and J. Johnson. Dated September 9th.

19,264. "Improvements in electric meters." C. Cante. Dated September 9th. (*Complete.*)

19,265. "Improvements in coin-freed mechanism for electric meters." C. Cante. Dated September 9th. (*Complete.*)

19,270. "Improvements in or relating to electrical signalling apparatus for use in gaseous or wet mines and for analogous purposes." P. Jerrard. Dated September 10th.

19,313. "Improvements in shade and lamp holders for incandescent electric lamps." S. H. Smith and J. H. Smith. Dated September 10th.

19,329. "Improvements in or relating to the manufacture of carbons or carbon pencils for electric lighting." S. Schreiber. (A. Bein, Austria.) Dated September 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. (*in stamps*).

1898.

4,409. "Third rail underground electric railway system." W. Wheatley. (L. Walkins.) Dated February 22nd, 1898. Relates to a third rail underground electric railway system, the object of the invention being to support the third rail used as a conductor for the motor current. The conduit is oval, or approximately that form, and comprises the outer section of hard cement, and an inner section of an insulating material which closely adheres to and is as one with the outer cement conduit section. The conduit has midway between its base and top, at opposite sides, rests or sockets on which are supported the transverse ties. On these ties is supported the longitudinally running trough which has, preferably, a lining of mica. The conductor rail is mounted with its base in this trough its tread portion being somewhat above the top edges of the trough side. 6 claims.

8,301. "Improvements in the construction of Morse's registering telegraphic instruments." E. Ducretet. Dated April 6th, 1898. Relates to certain improvements made in Morse's telegraphic receivers. It consists in an arm made integral with a lever and adapted to come into contact at each attraction of the armature by the electro-magnet, with a springy or resilient blade secured to a stationary shoe and adjustable by means of screws. The arm is provided at its lower end with a small screw by means of which the contact between said arm and the resilient blade is established and may be regulated. The clockwork mechanism of apparatus is automatically thrown into or out of gear in the following manner, whatever may be the use of the receiver, the first contact between the screw and the blade acts on an auxiliary electro-magnet with the local battery to produce the attraction of an iron bar having a long throw or travel; this attraction being effectuated either direct or through the intermediary of an armature. 1 claim.

8,438. "Improved apparatus for electrically illuminating or displaying letters, figures, designs, pictures, signals, and their like, principally adapted for advertising purposes." J. T. Gent. Dated April 9th, 1898. Relates to an apparatus for switching on and off lamps in electrical illumination, characterised by a number of non-conducting grooves or channels containing mercury, which forms a terminal within the circuit conducting carriers (independent of each other), having upon them contacts which are either directly or indirectly connected to the circuit, and which said carriers are each arranged so that the contacts thereon dip into, or leave the said grooves or channels simultaneously and together, and a holding and releasing mechanism capable of giving a quick and semi-automatic "make" and "break." 5 claims.

11,440. "Improvements in dynamos." G. Unterberg. Dated May 17th, 1898. This invention for improvements in dynamos relates to a new dynamo. In the suitably constructed bearings of the frame is mounted the shaft of the dynamo, one end of which is furnished with a driving pulley. On the shaft the armature formed and wound after the fashion of a Gramme ring is fixed. The core of this ring is composed of separate rings of good soft wrought-iron around which the armature windings are placed in separate divisions adjoining one another. The free ends of the windings are directed to the commutator and are firmly fastened in the segments thereof by screws. An important departure in a dynamo constructed according to this invention, is that horse-shoe cores are not made use of in any way, but that the winding is applied only to a thin sheet iron spool which in its turn surrounds the greater portion of the periphery as well as the side surfaces of the ring armature. 2 claims.

13,478. "Improvements in or relating to apparatus for controlling electric currents of high tension and great quantity." E. Johnson and R. Lundell. Dated June 16th, 1898. Relates to apparatus for use in connection with electric motors, and consists of a controller drum having a number of circuit controlling contact strips arranged thereon for affecting the proper current changes in any prearranged order through a starting resistance, a series of binding posts are provided with contact brushes and are adapted to bear upon the strips as the roller drum is rotated. 2 claims.

14,101. "Improvements in surface contact railway systems." The British Thomson-Houston Company, Limited. Dated June 25th, 1898. Relates to surface contact railway systems, and has for its object to provide a time overlap for the switches, which are actuated by current from the contact shoes, and this is attained by insuring the prompt closing of each switch in succession. The shoe is divided into two parts, between which is connected the resistance. A section of insulating material being placed between the parts of the shoe. As soon as the shoe touches the contact next the one upon which it is resting, a great part of the motor current will pass to the ground through this contact on account of the insertion of resistance. Sufficient current, however, will still pass the resistance to hold the switch closed. 7 claims.

14,112. "Improvements in or connected with primary batteries." A. Peters. Dated June 24th, 1898. Relates to the employment of a special depolarising electrode by means of which polarisation is obviated, and a constant current of high electromotive force is obtained. This electrode, which is employed as the negative element, that is to say, the element constituting the positive pole of the battery, consists of peroxide of lead electrically prepared from a lower oxide such as litharge or red led. The said peroxide of lead is held or supported by a lead plate frame or grid, and is immersed in any suitable electrolyte. As a positive electrode, that is to say, the electrode which constitutes the negative pole of the battery is employed, zinc, iron, or tin, which, when desired, may be amalgamated. 7 claims.

14,800. "Improvements in, and relating to, electric heaters, rheostats, and the like, having comminuted resistance for the electric current." R. Van Reusselaer Sill. Dated July 5th, 1898. Relates to an electric heater or rheostat in which the resistance filling of comminuted material, preferably of carbon and soapstone, is deposited in a spiral layer with the convolutions in contact so as to obtain uniform density throughout its length. 2 claims.